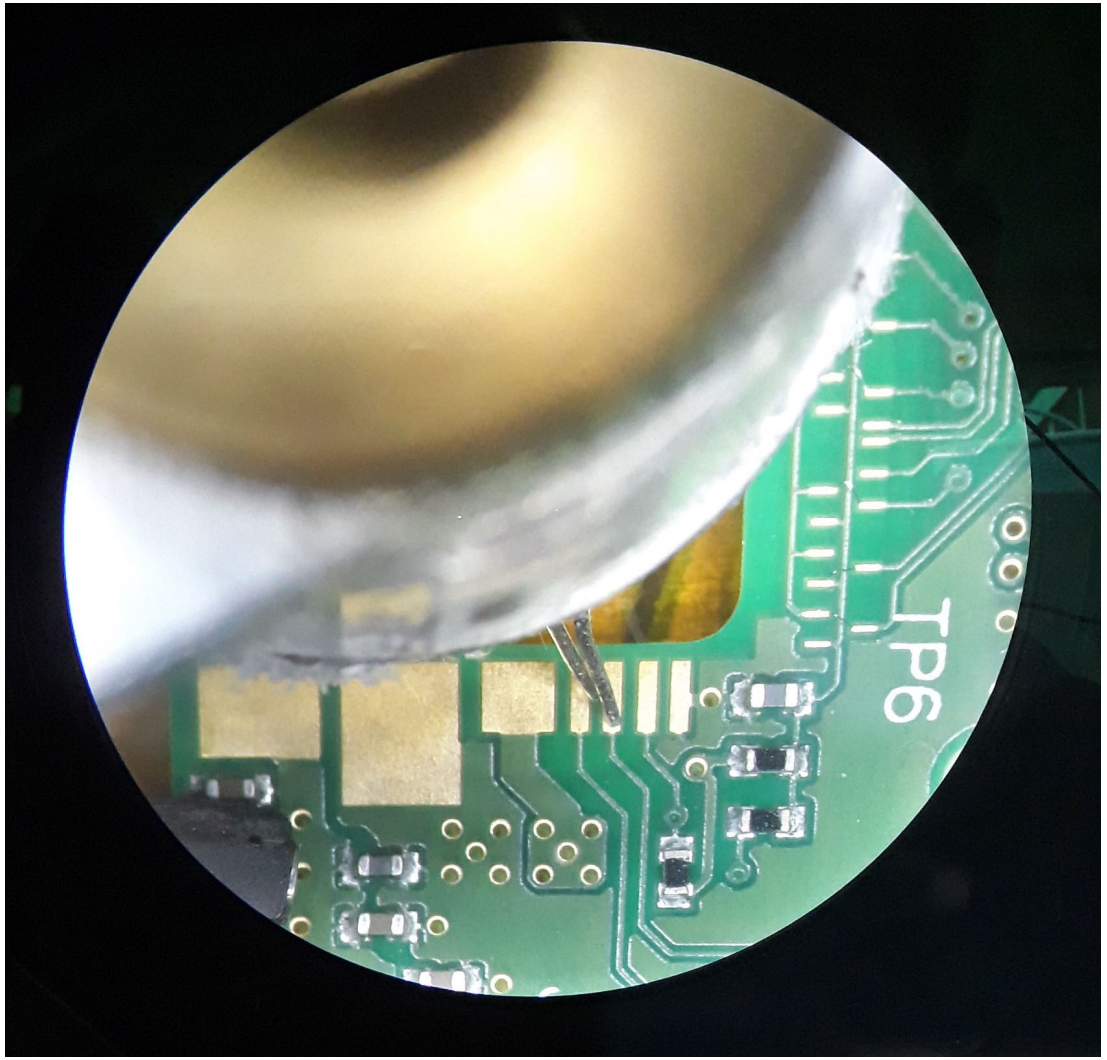
The Effect of Power Supply Noise on EoS Card Behaviour

Chaimongkol Duangchan

Supervisor: Chaowaroj (Max) Wanotayaroj

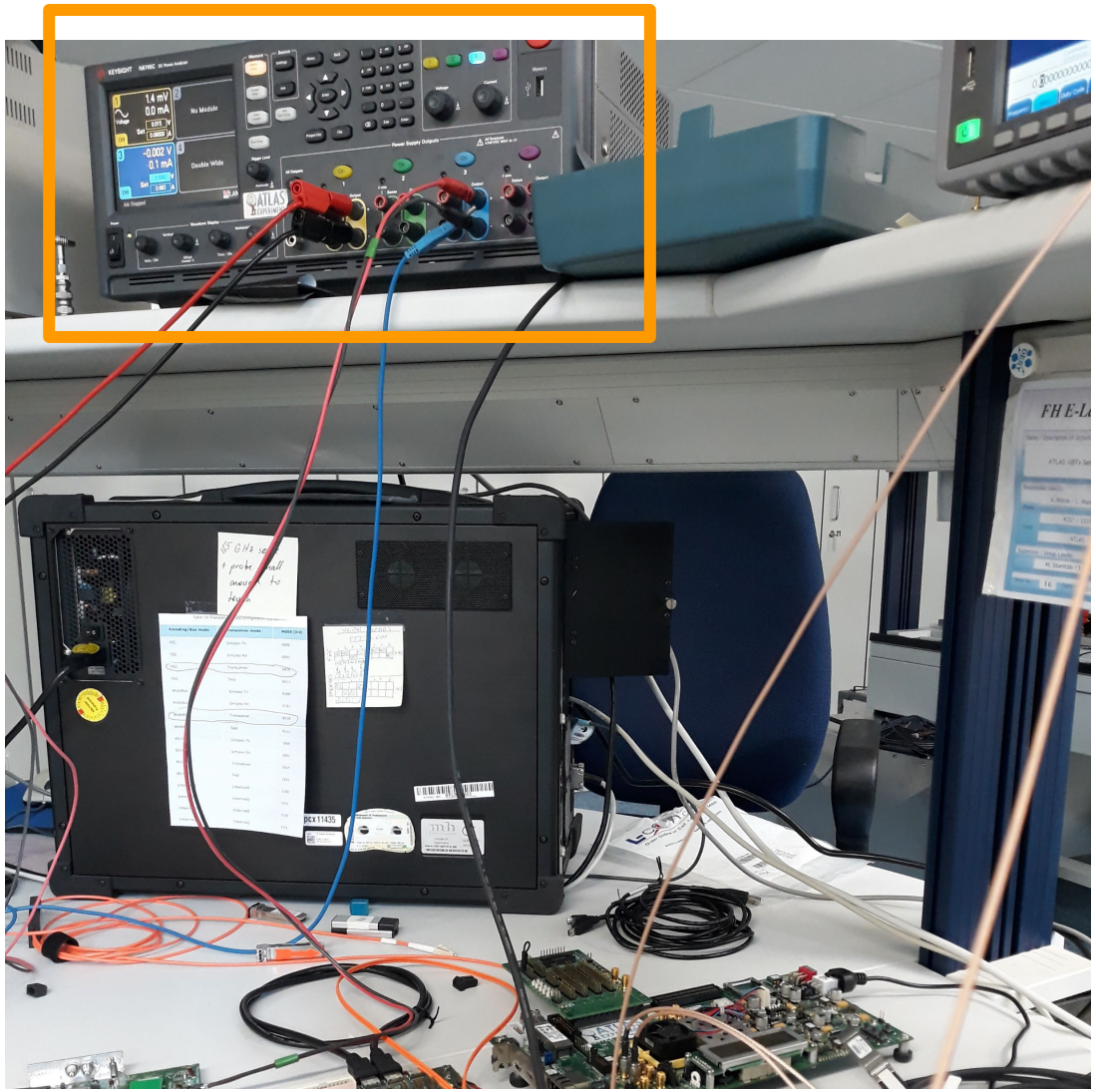
EoS Card



EoS Card under microscope

- Briefly saying, it is a bridge between what inside the event and an outside world
- If it’s broken, we lose information on that part of detector.
- Needs 1.5-1.25V power supply to operate, and 0.2V to maintain configuration.
- Looking for effect of noisy power supply.

Noise

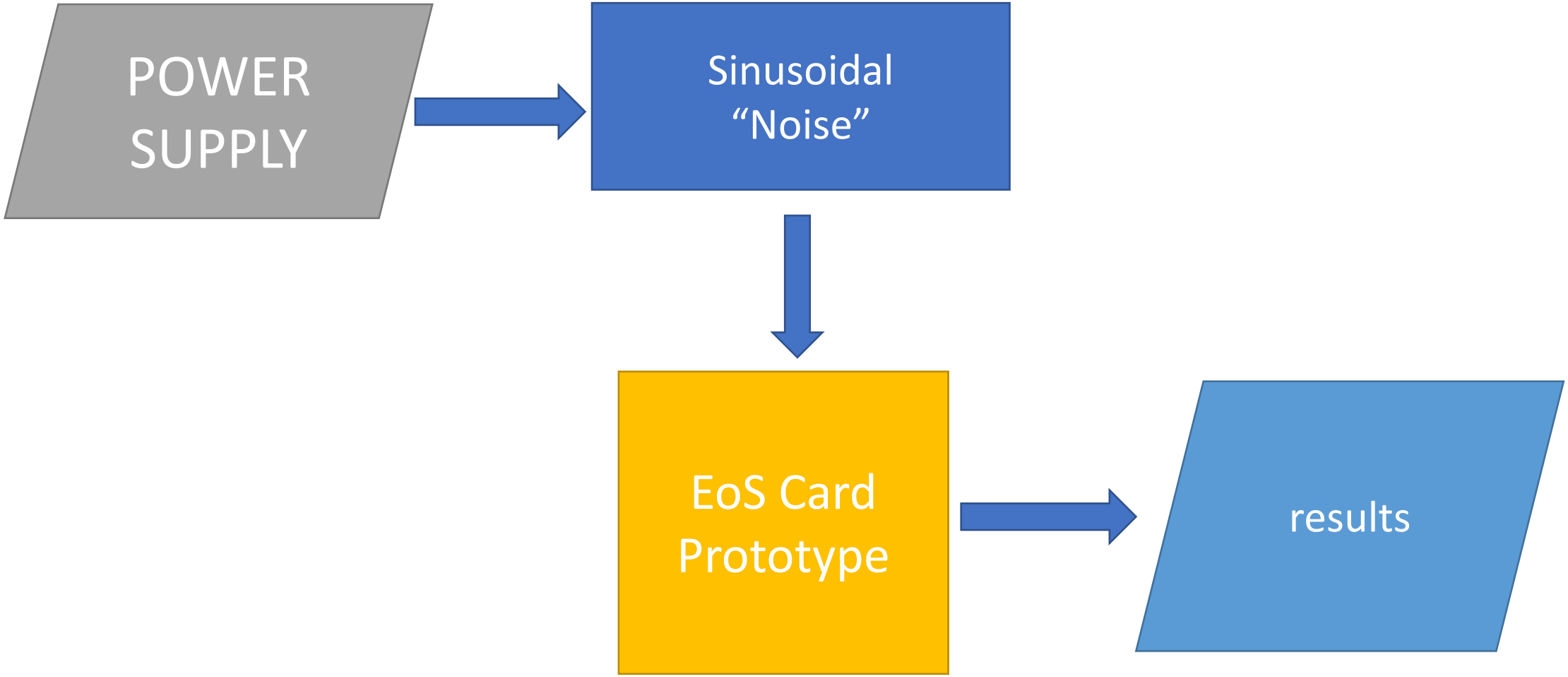


Here my work desk all the time.

- Keysight N6705C power supply is used here to make the noise.
- It can generate sinusoidal waveform up to 10kHz.
- The term “Noise” here means the sinusoidal function at some amplitude and frequencies.

Procedures

- Sinusoidal waveform is used to ensure the same noise pattern.
- Making sure that it is the same environment every test.



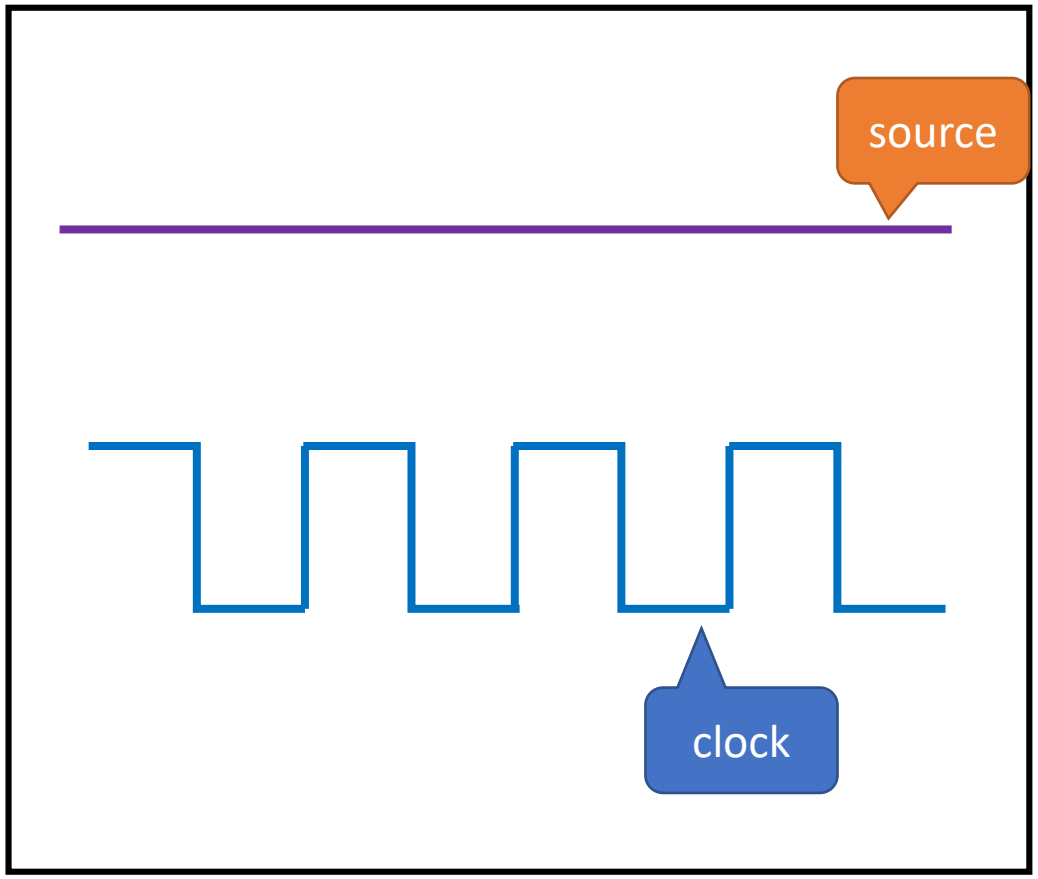
Results

- Clock and Input Signal
- DAC – Digital Analog Converter
- ADC - Analog Digital Convert
- Machine State

Clock Signal

- I purposely set source voltage to 1.6V
- Clock signal expand its level and I called V0.

Constant Voltage



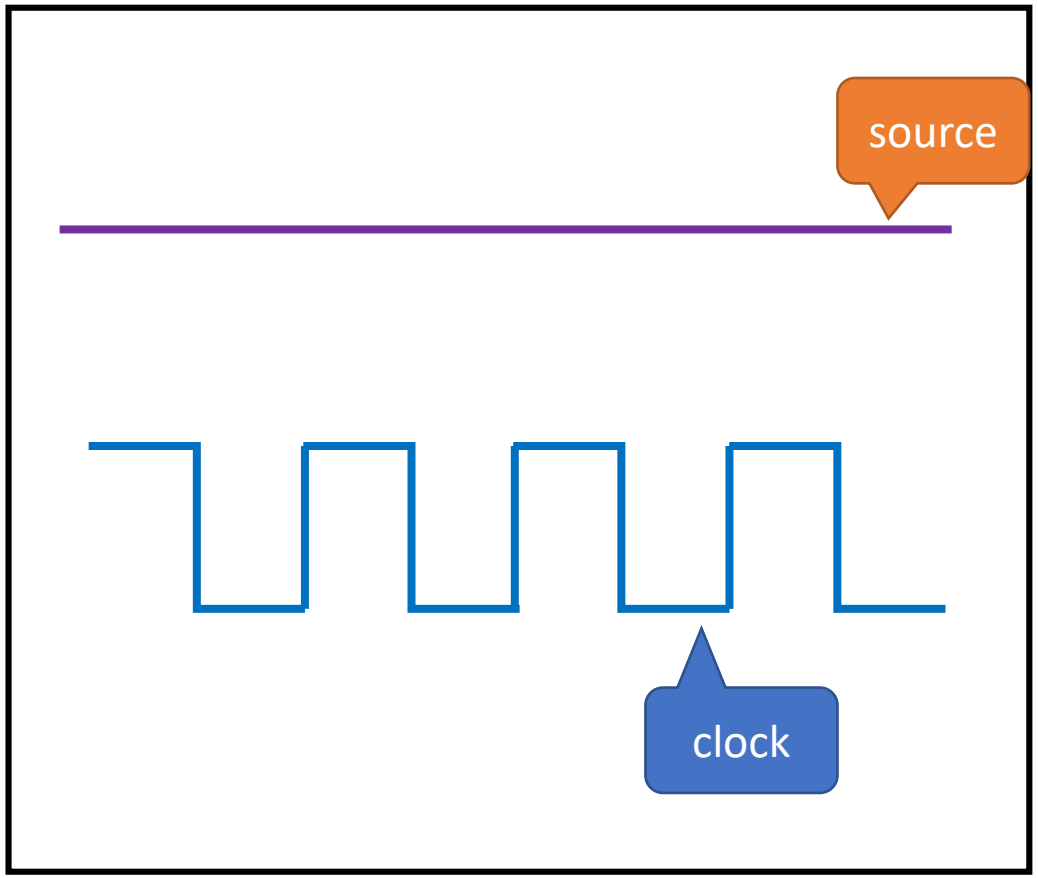
Constant voltage with higher level

Clock runs at 40 MHz.

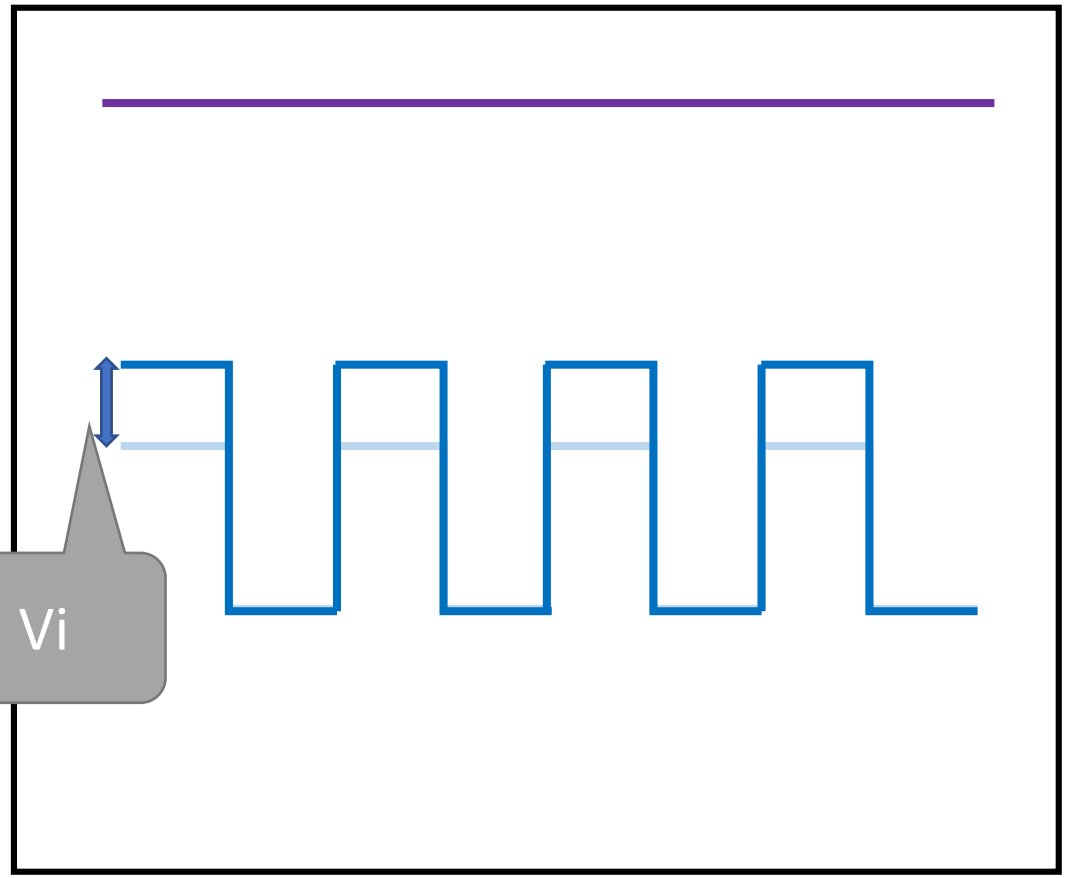
Clock Signal

- I purposely set source voltage to 1.6V
- Clock signal expand its level and I called V0.

Constant Voltage



Constant voltage with higher level

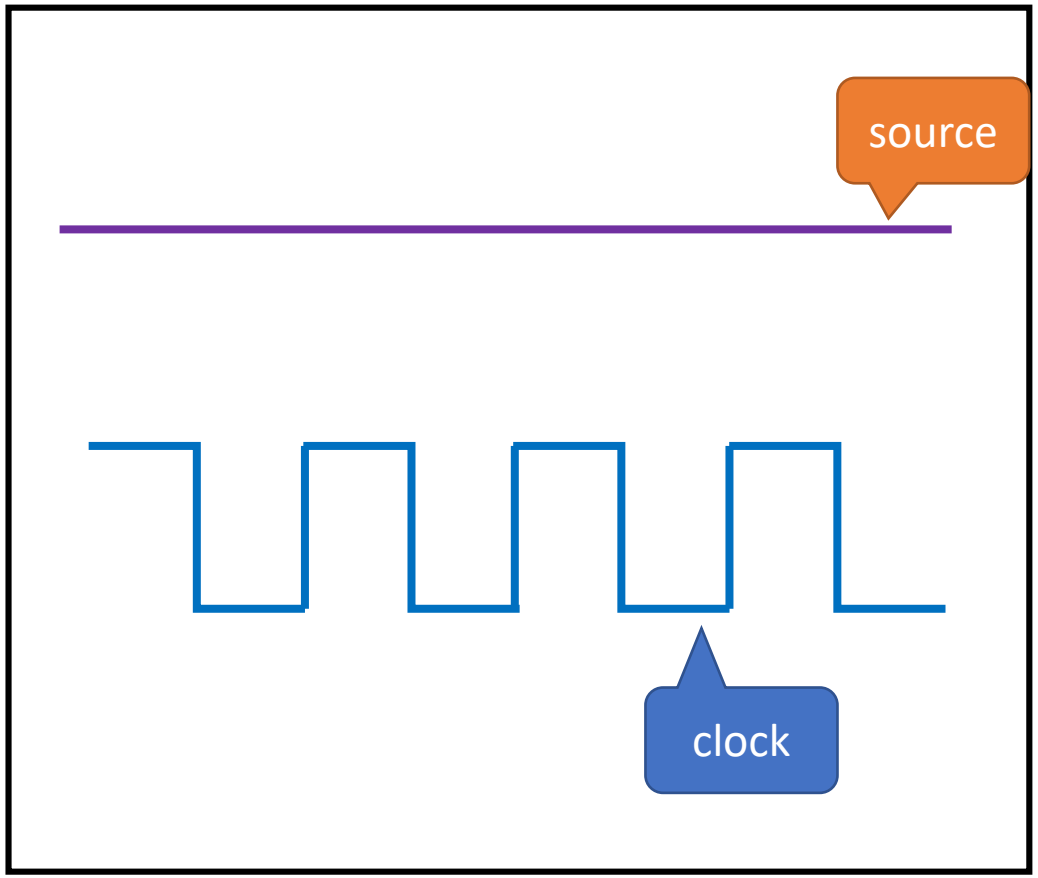


Clock runs at 40 MHz.

Clock Signal

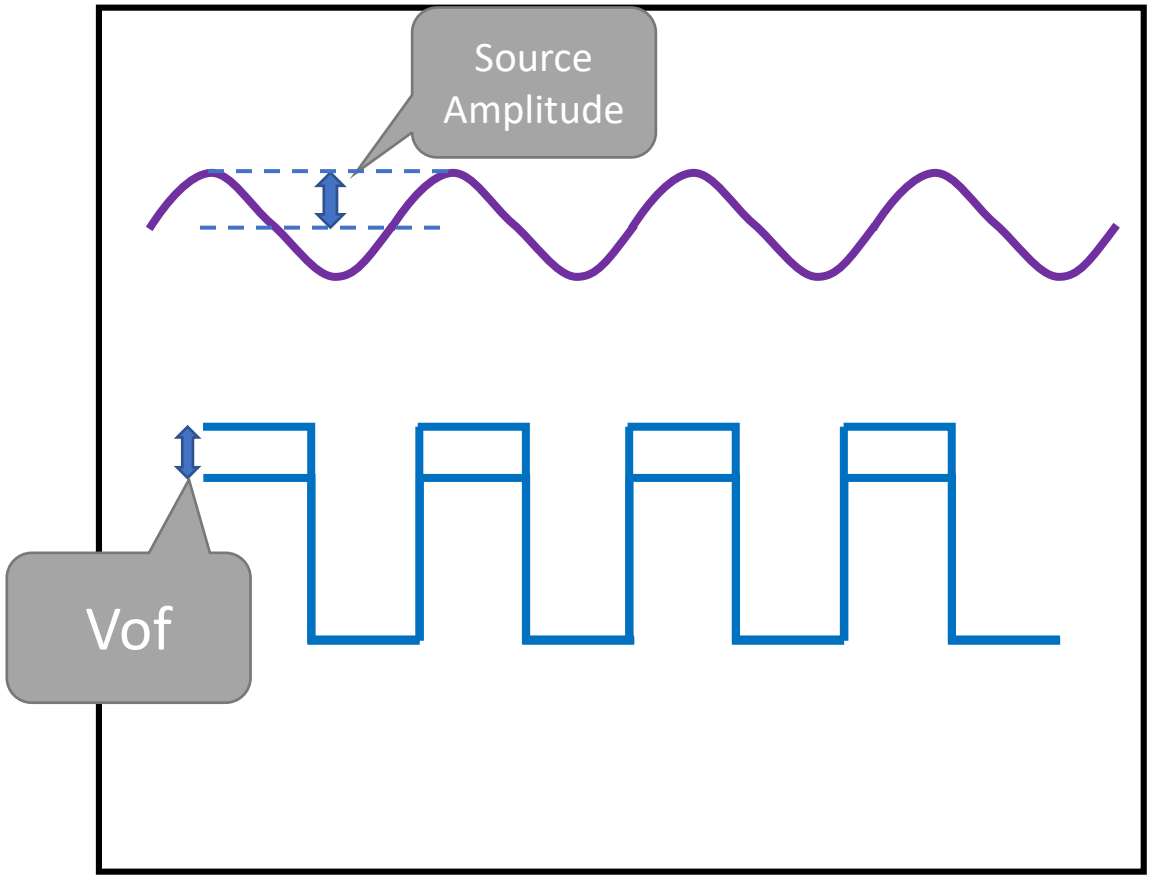
Here I use 150 mA source amplitude, and vary the frequency.

Constant Voltage



Clock runs at 40 MHz.

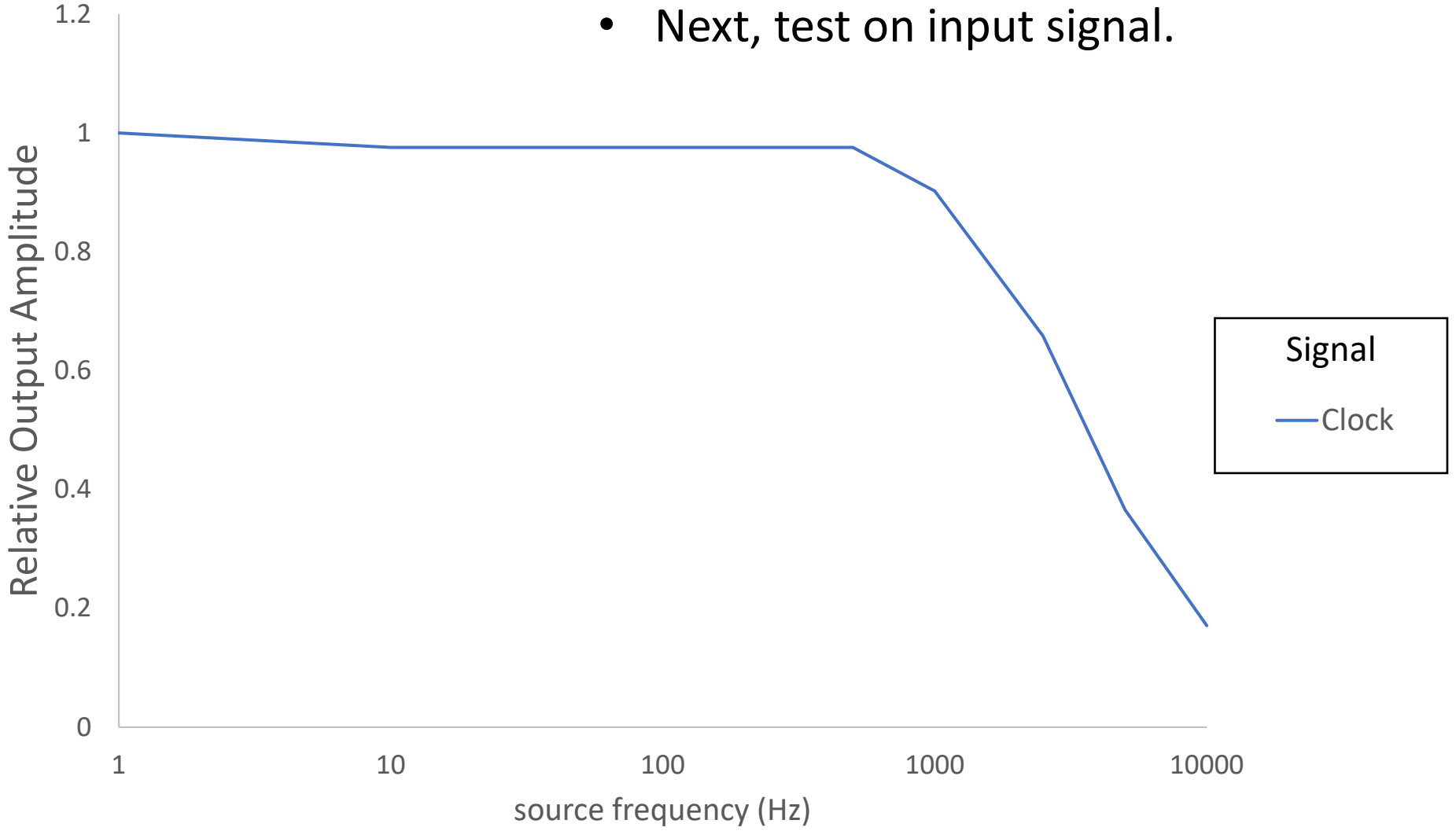
Sinusoidal noise



Relative output amplitude = $\frac{Vof}{Vi}$

Clock Signal

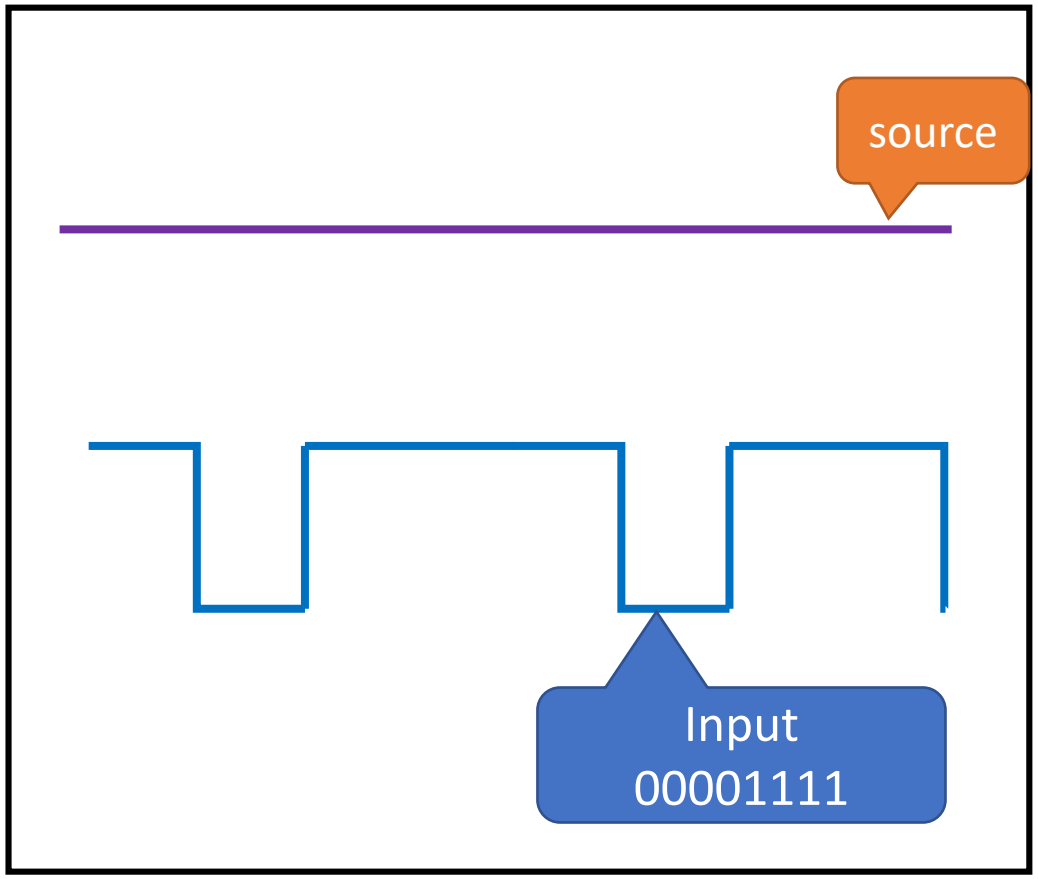
- The effect decreases on higher frequency.
- This shows the low pass filter.
- Next, test on input signal.



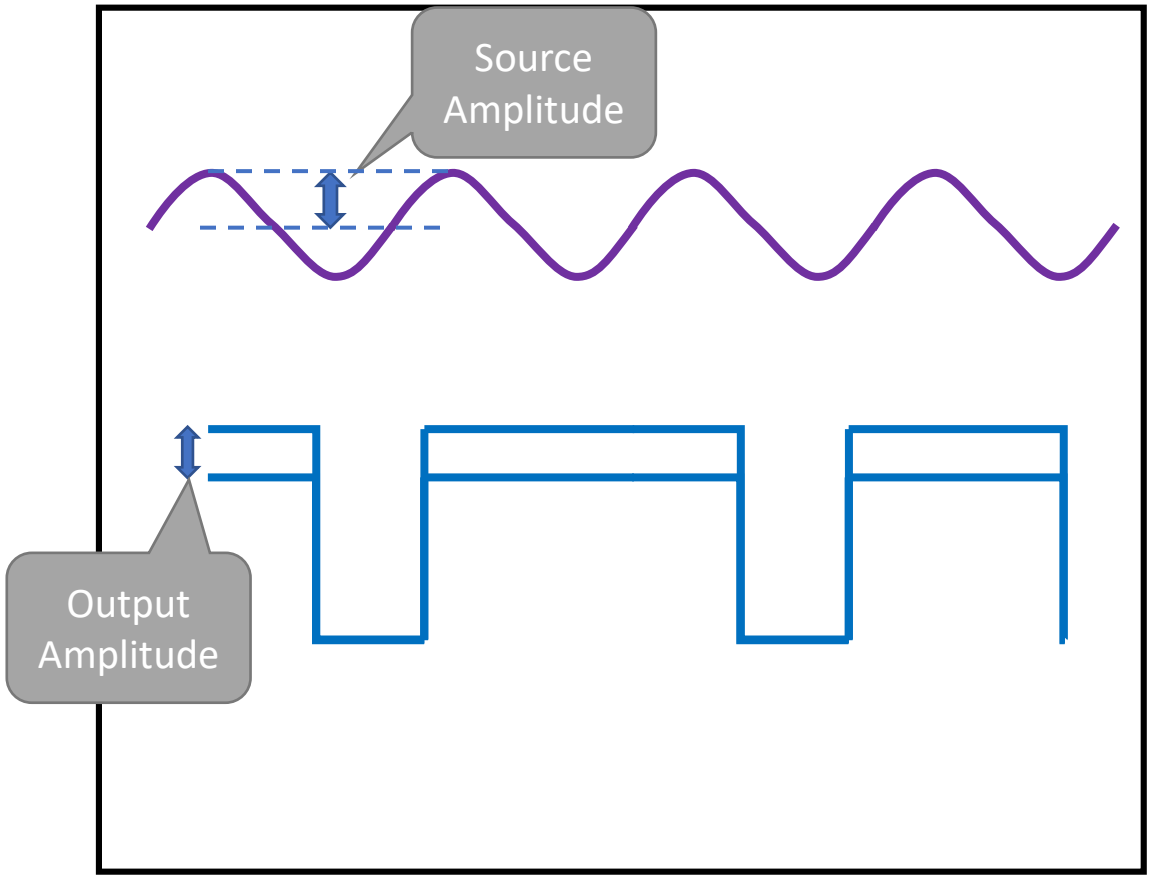
Input Signal

The same criteria is applied and it still shows the same effect.

Constant Voltage



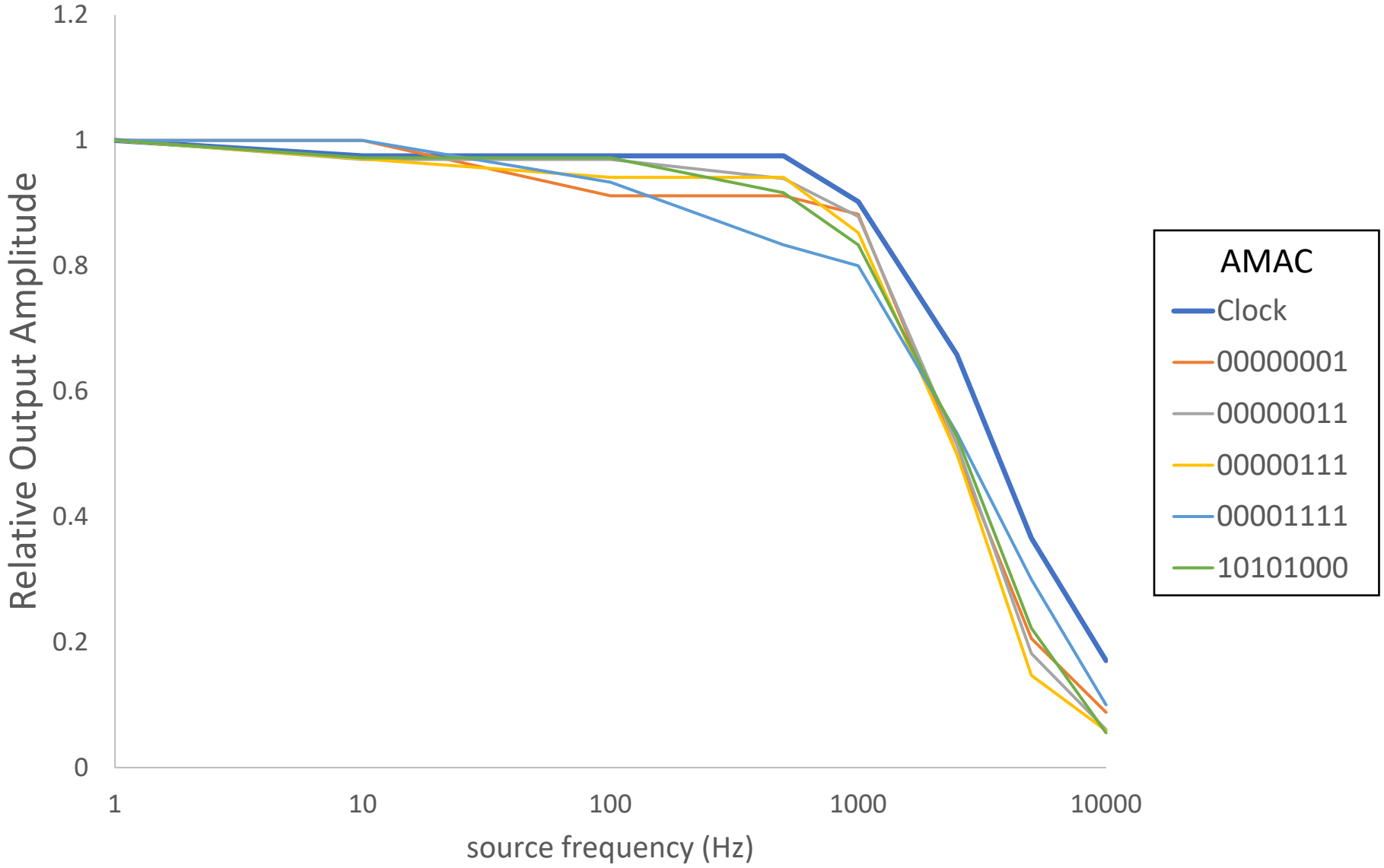
Sinusoidal noise



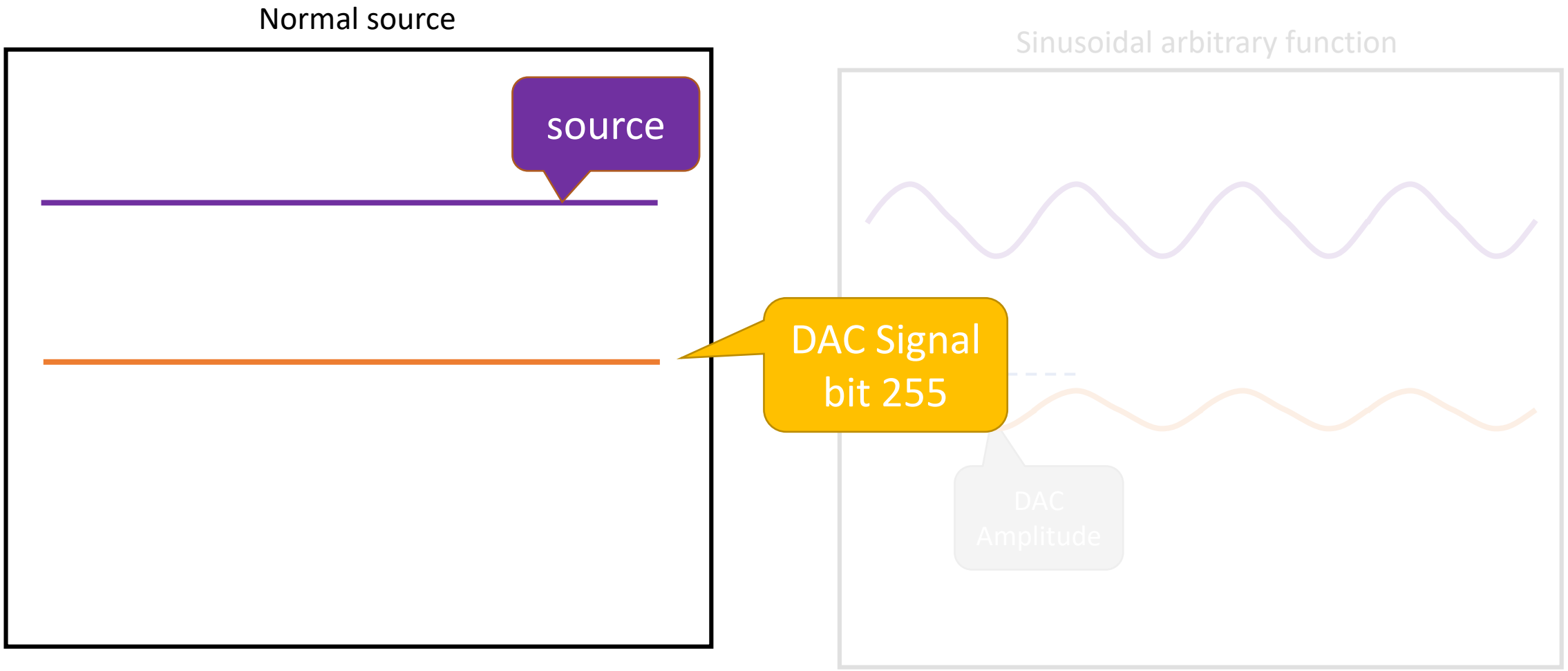
Some random input signal (00001111).

Input Signal

- The low pass characteristic still showing here.



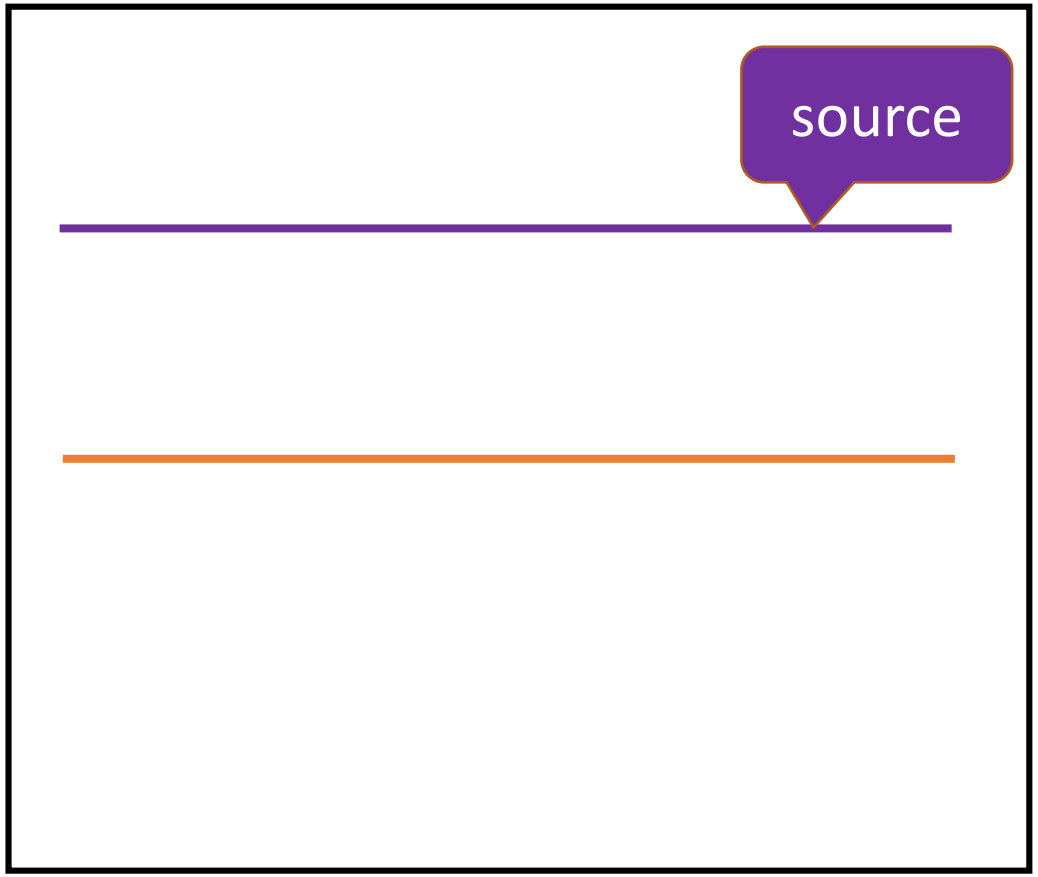
DAC



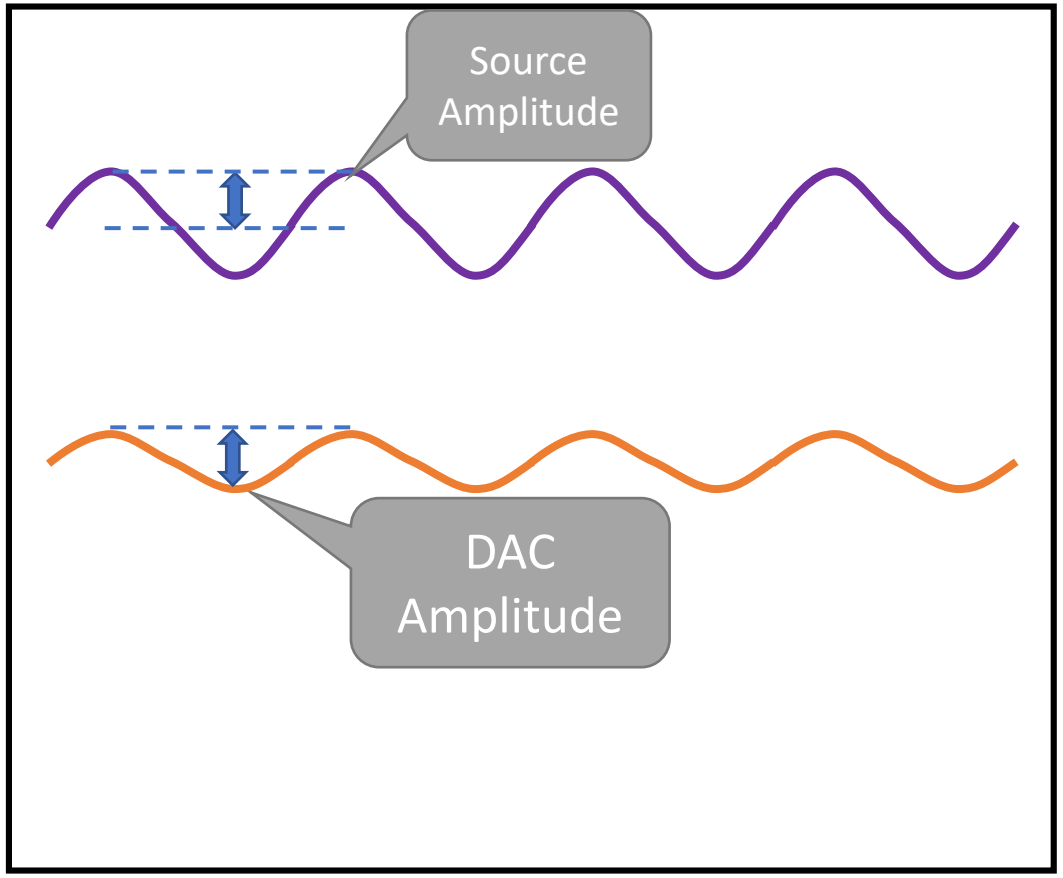
- DAC converts bit value to an analog signal.
- This is what the signal should be read.

DAC

Normal source



Sinusoidal arbitrary function

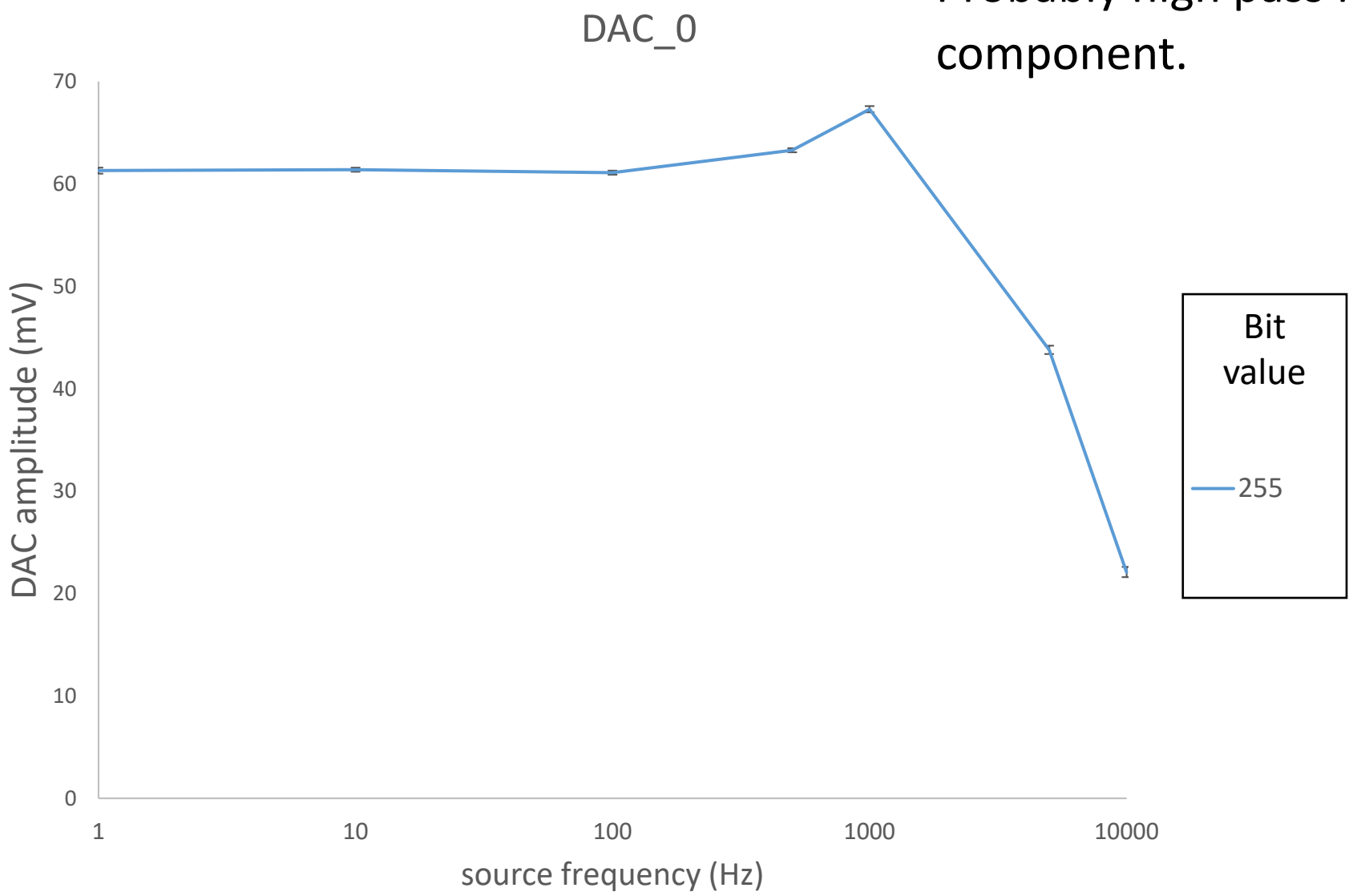


- DAC converts bit value to an analog signal.
- This is what the signal should be read.

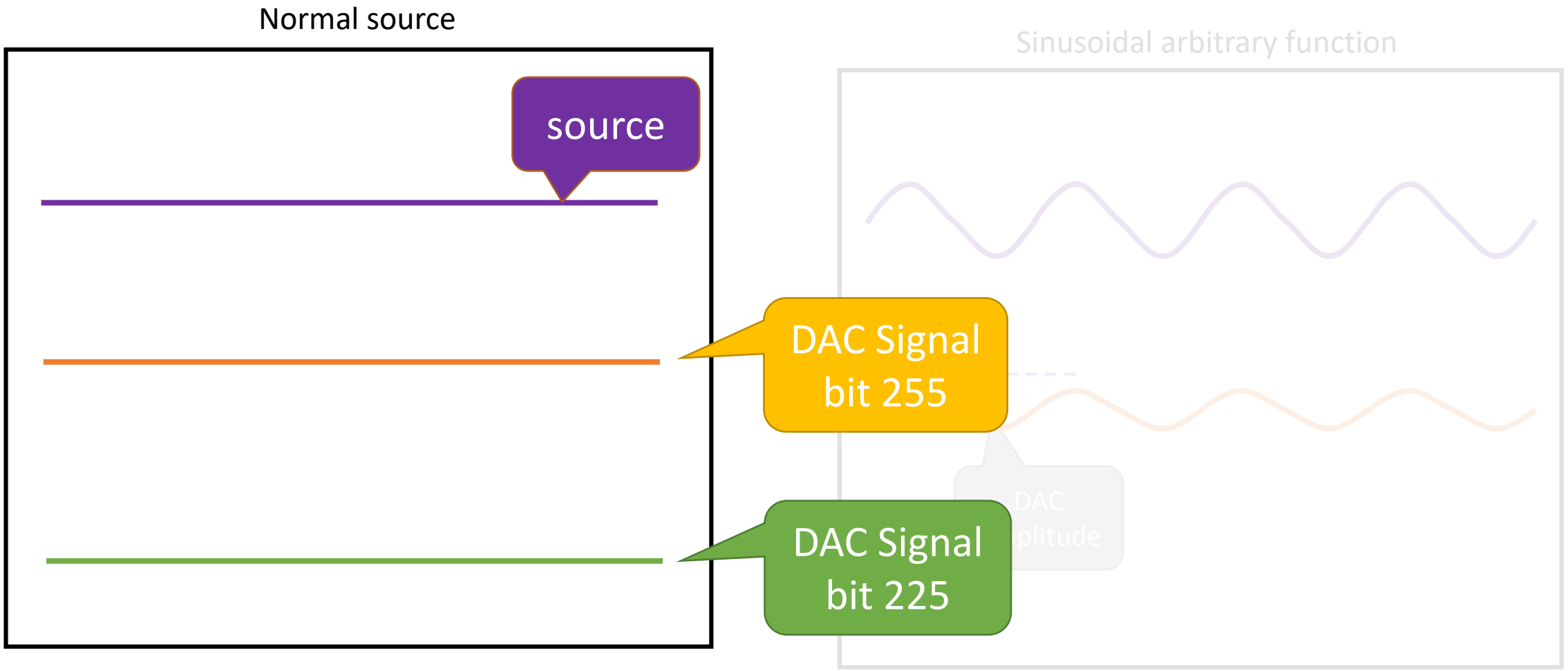
- DAC output do follow noise.
- Let's call it DAC amplitude

DAC

- Effect increases when higher frequency and then drop down.
- Probably high pass filter or multiple passive component.



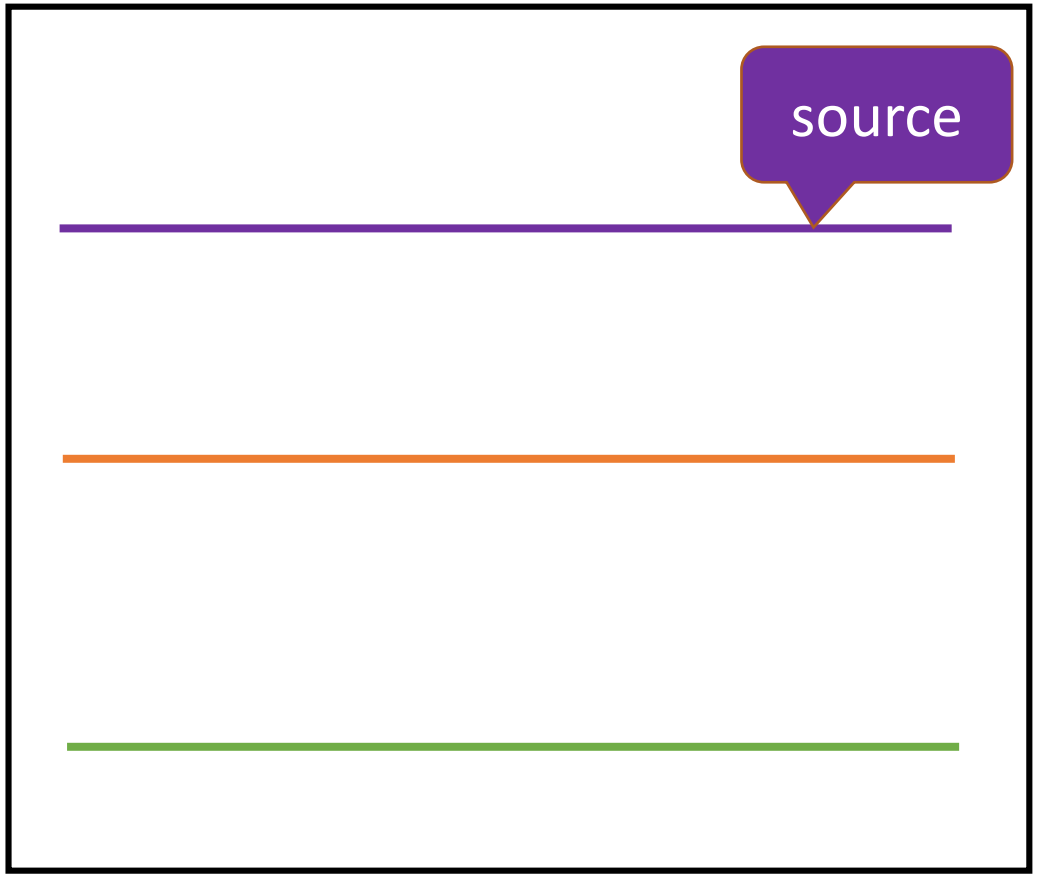
DAC



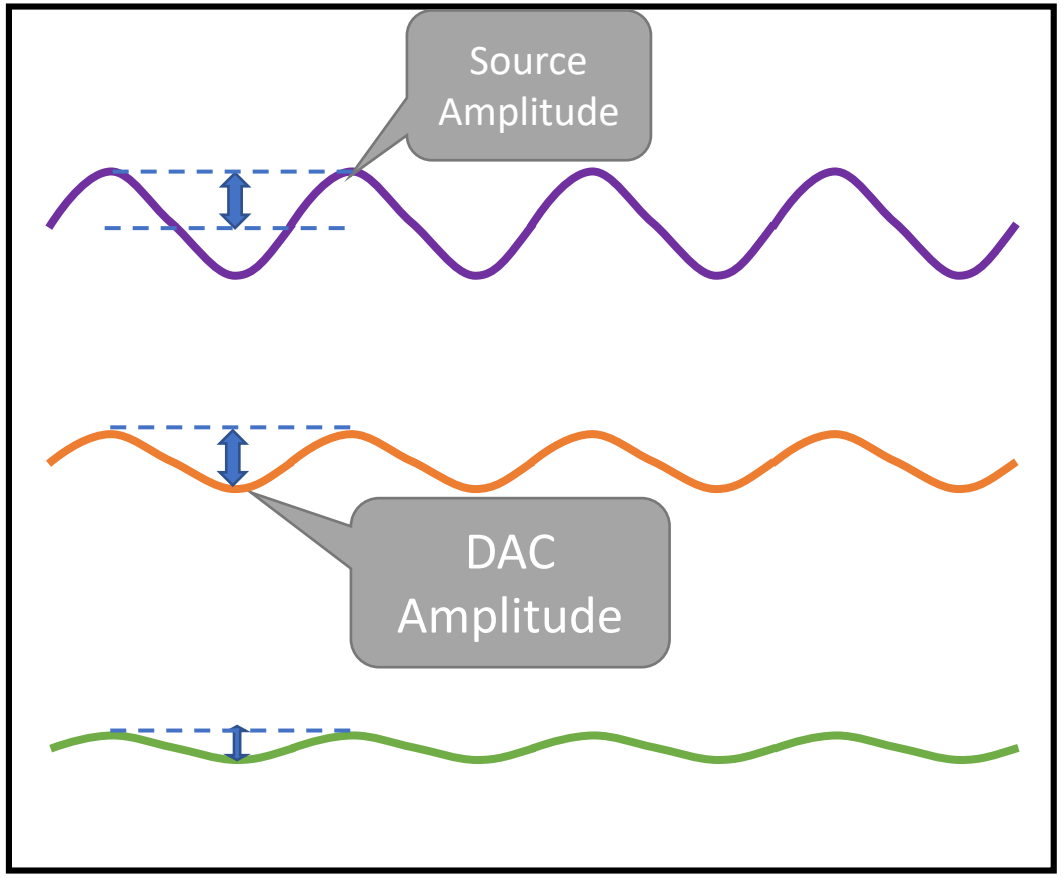
- DAC converts bit value to an analog signal.
- This is what the signal should be read.

DAC

Normal source



Sinusoidal arbitrary function

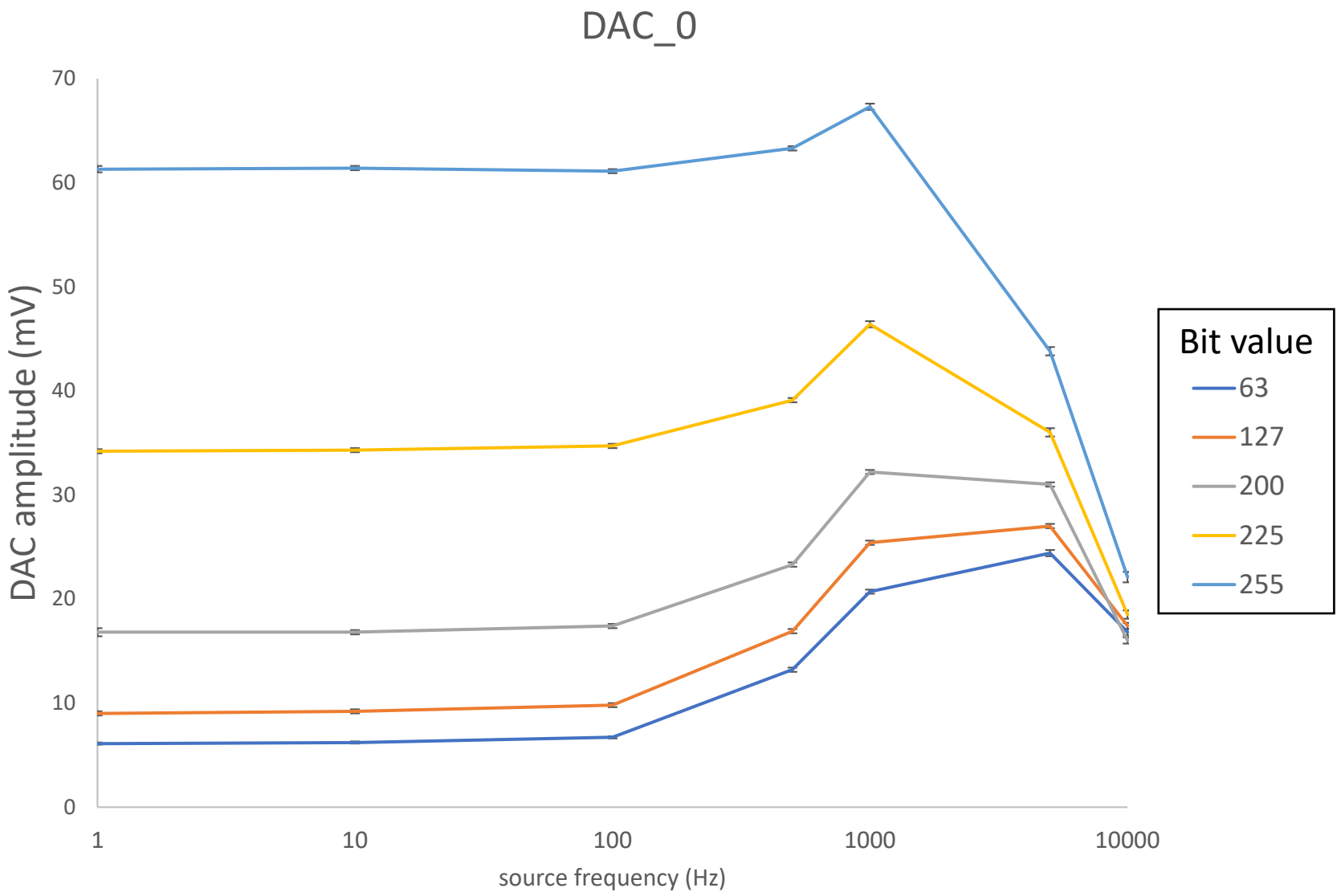


- DAC converts bit value to an analog signal.
- This is what the signal should be read.

- DAC output do follow noise.
- This effect depends on bit and noise form.

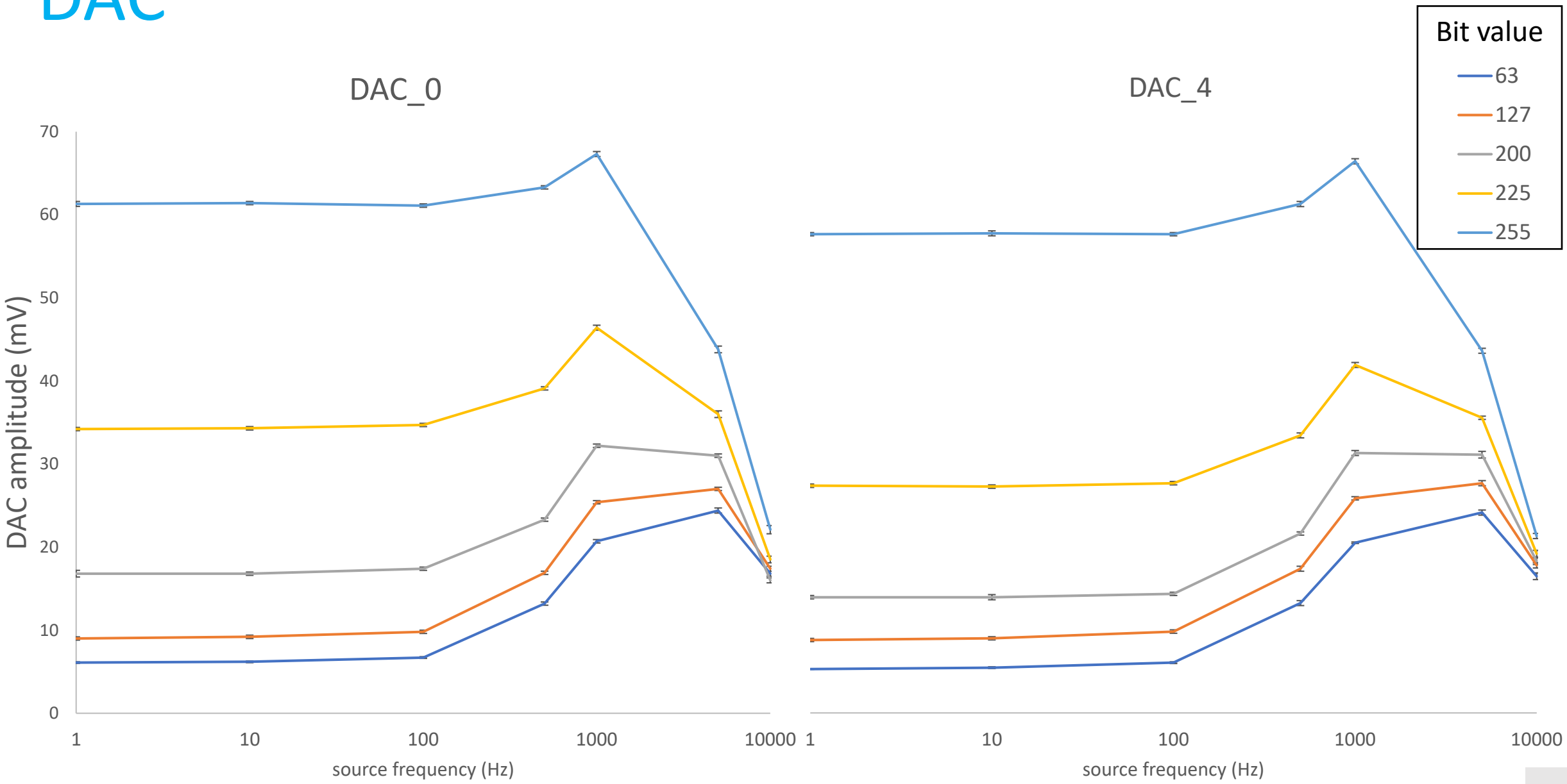
DAC

- Higher bit value is more disturbed.
- Noise is more effective in higher frequency.



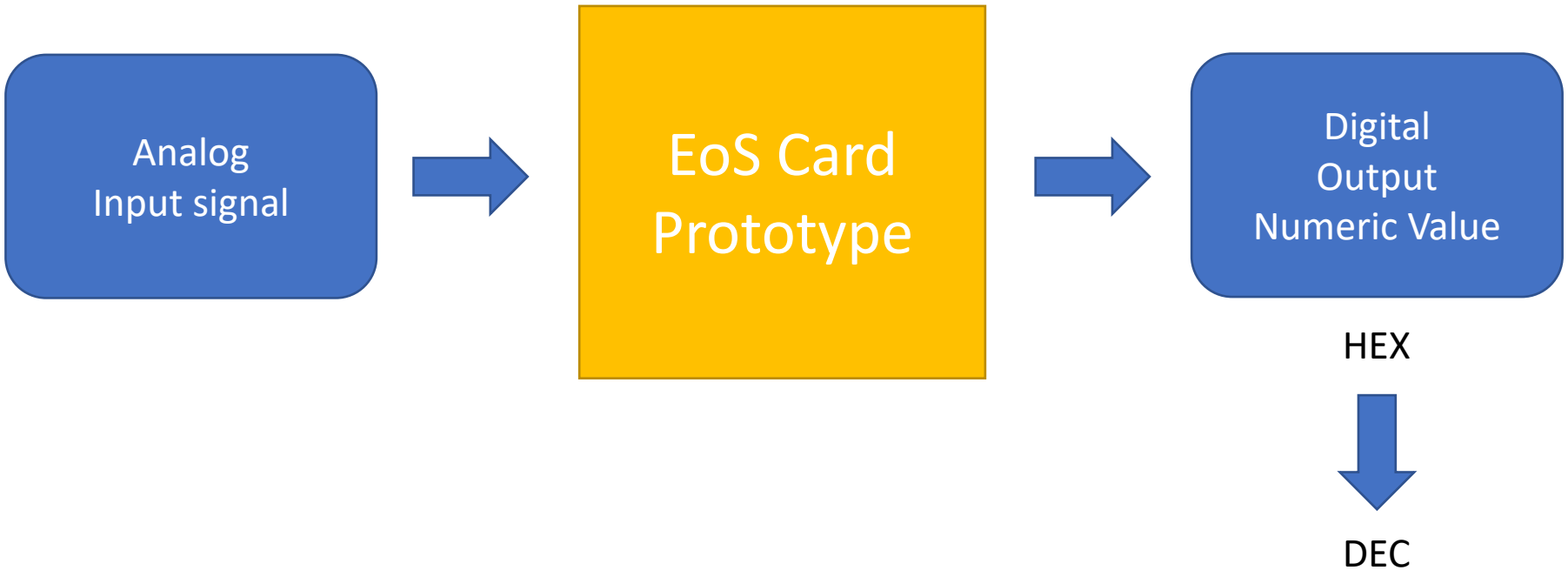
DAC

- Check on other channel to make sure it is not coincidence.

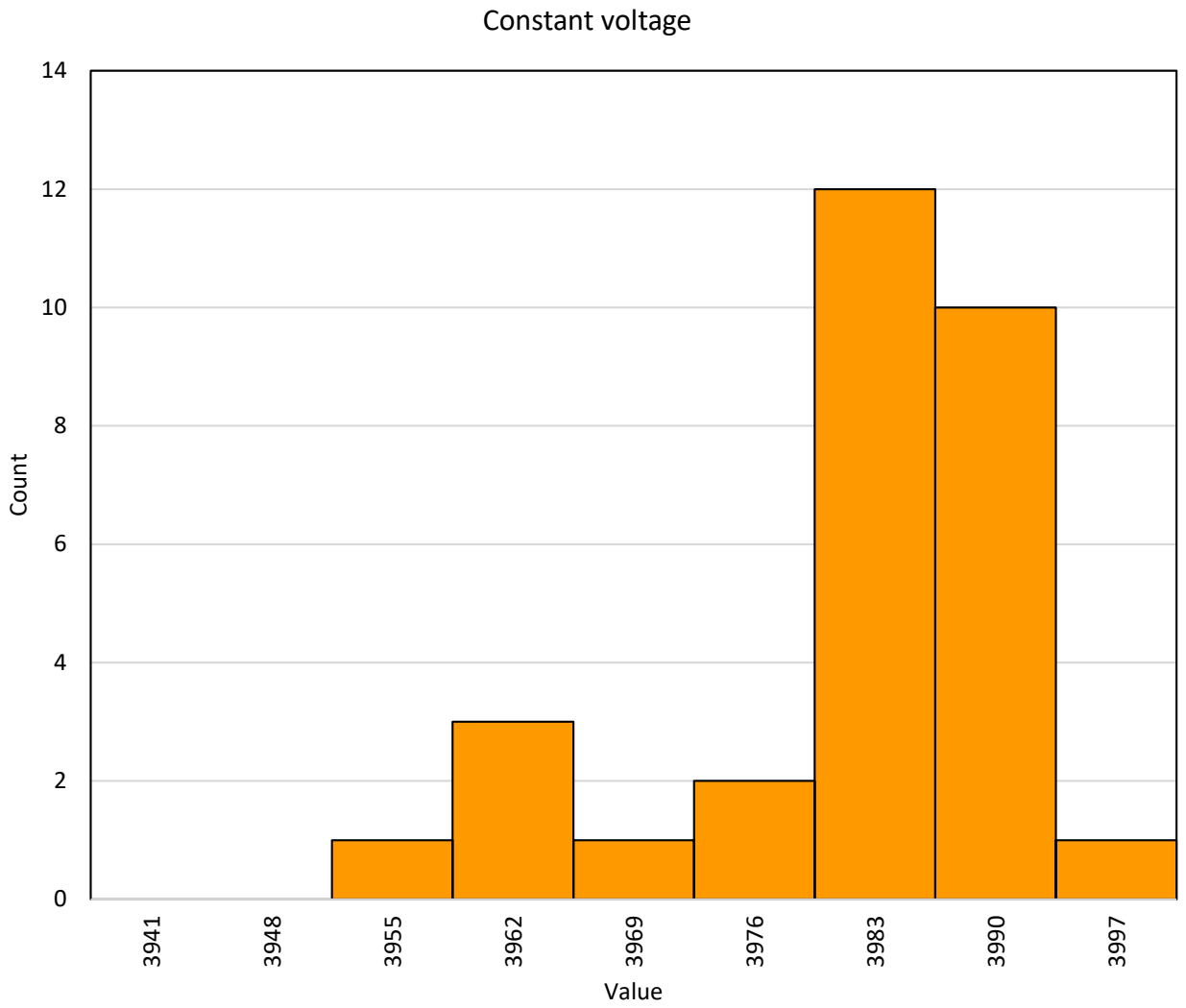


ADC

- ADC converts input signal to a numeric value.
- It acts as a voltmeter.
- Normally use for internal signal calibration.



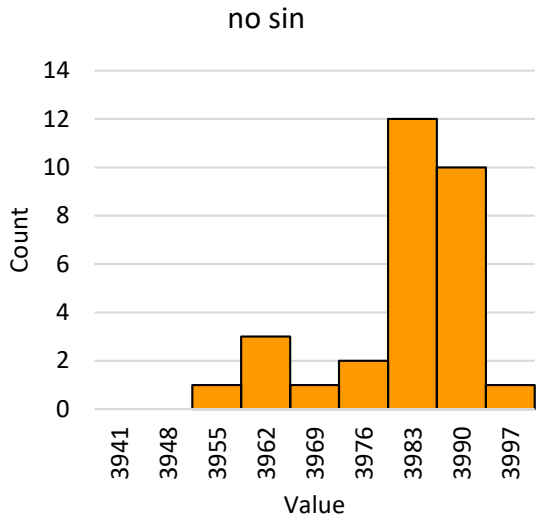
ADC

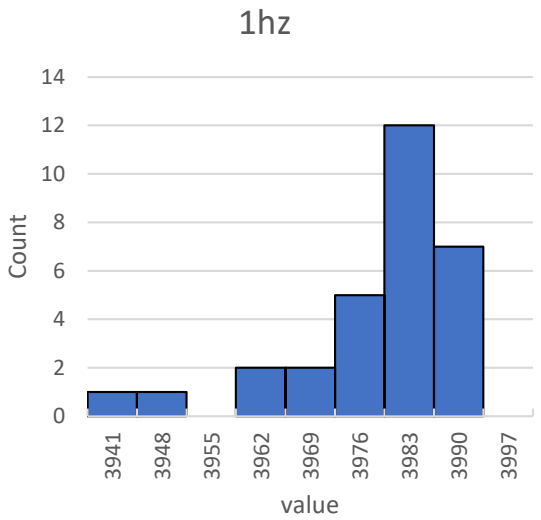


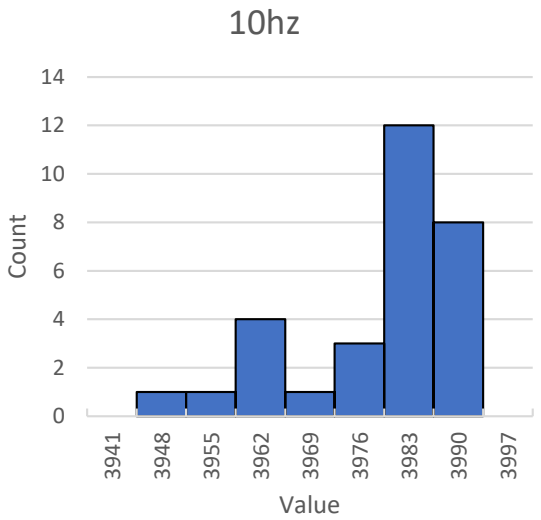
- I can read output one at a time.
- From histogram, it shows gaussian distribution with left skew.

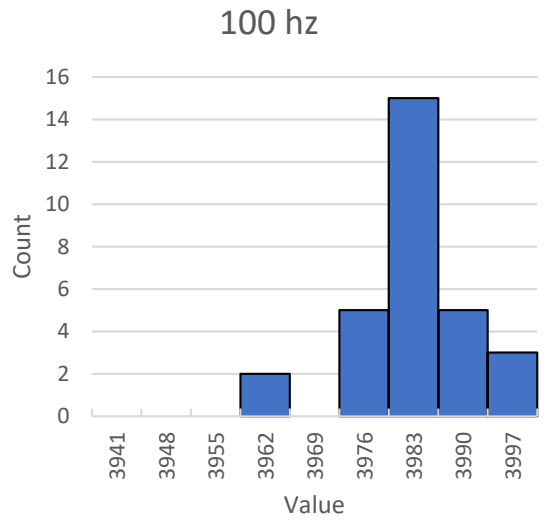
ADC

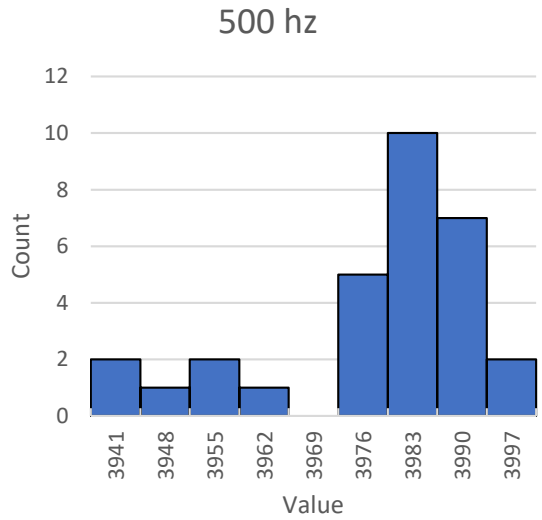
- Noise of 15mA amplitude
- Test on the noise and it shows the same.

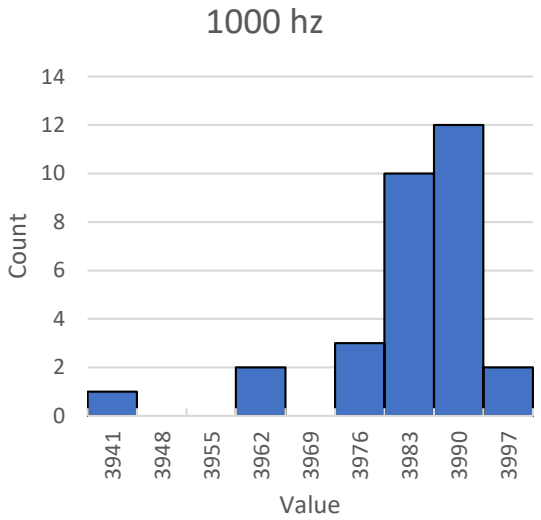


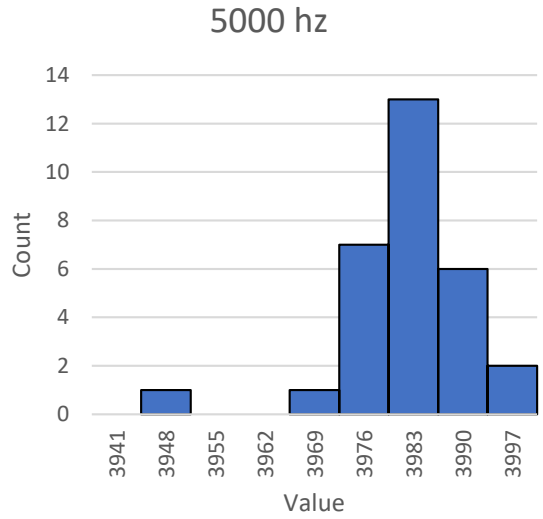


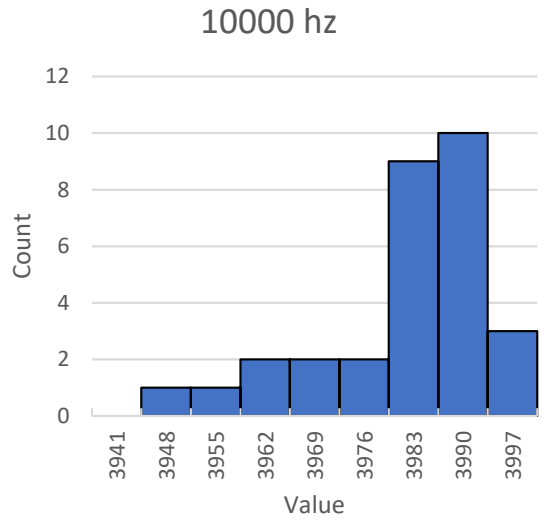






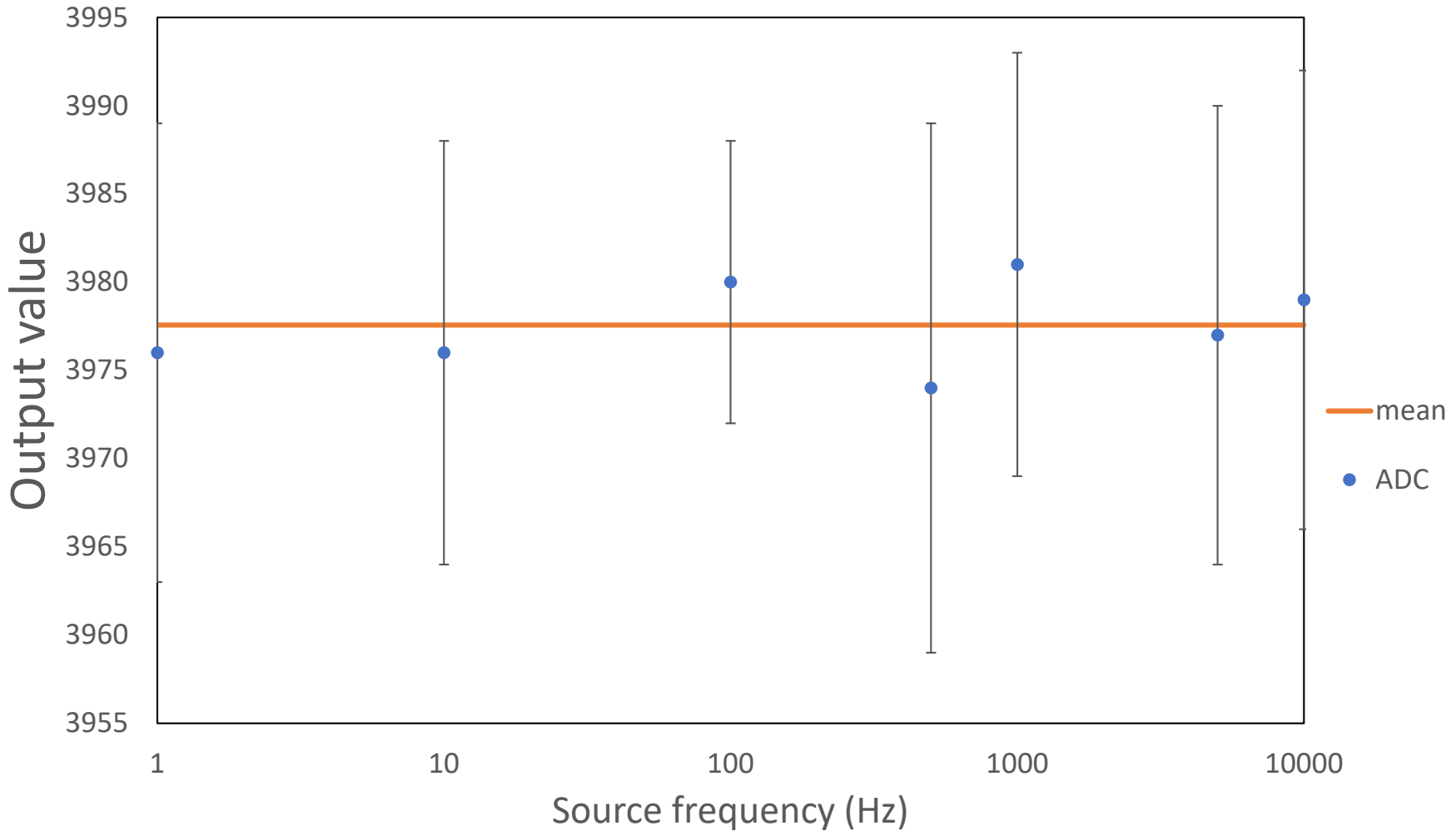






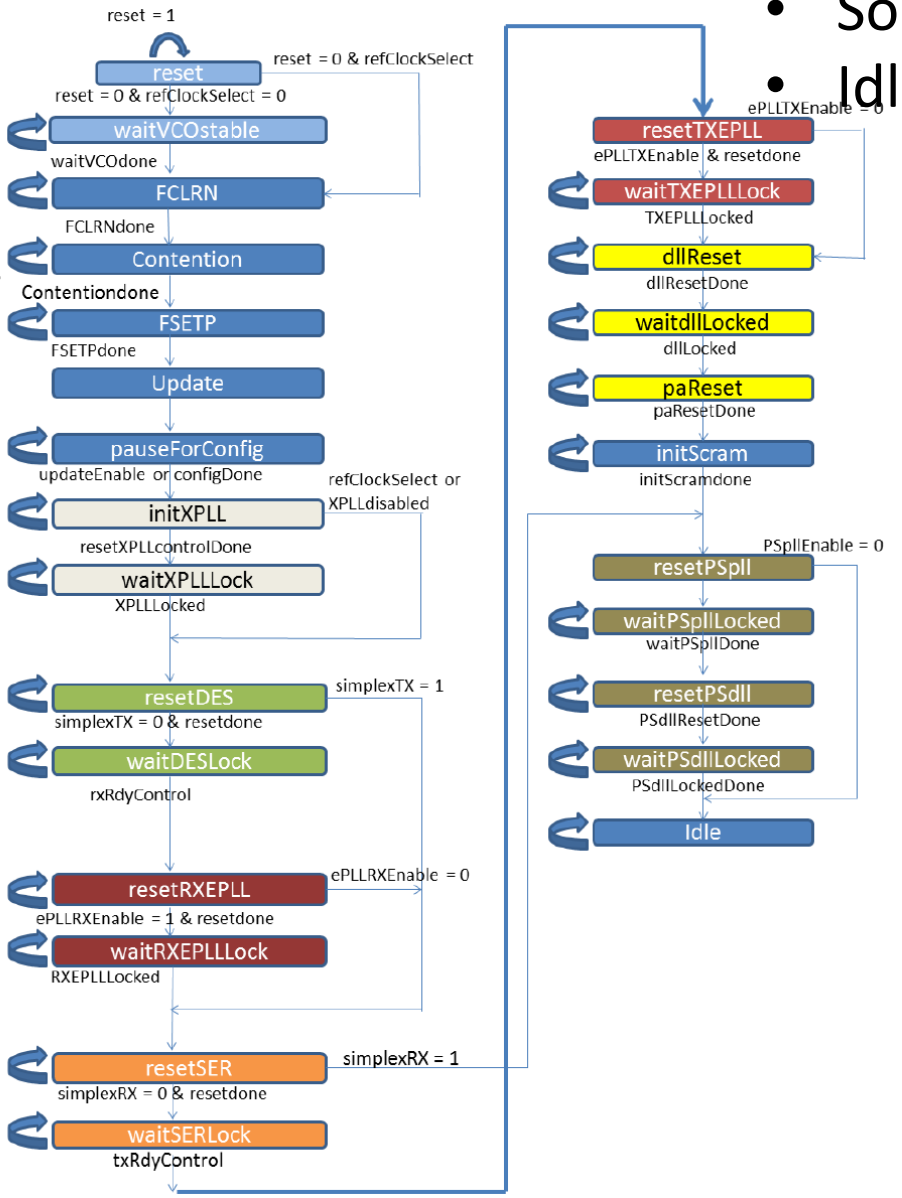
ADC

- To keep simple. Let assume it is gaussian only.
- Average values and S.D. are calculated for each frequency.
- This shows no significant effect under ADC resolution.



Machine State

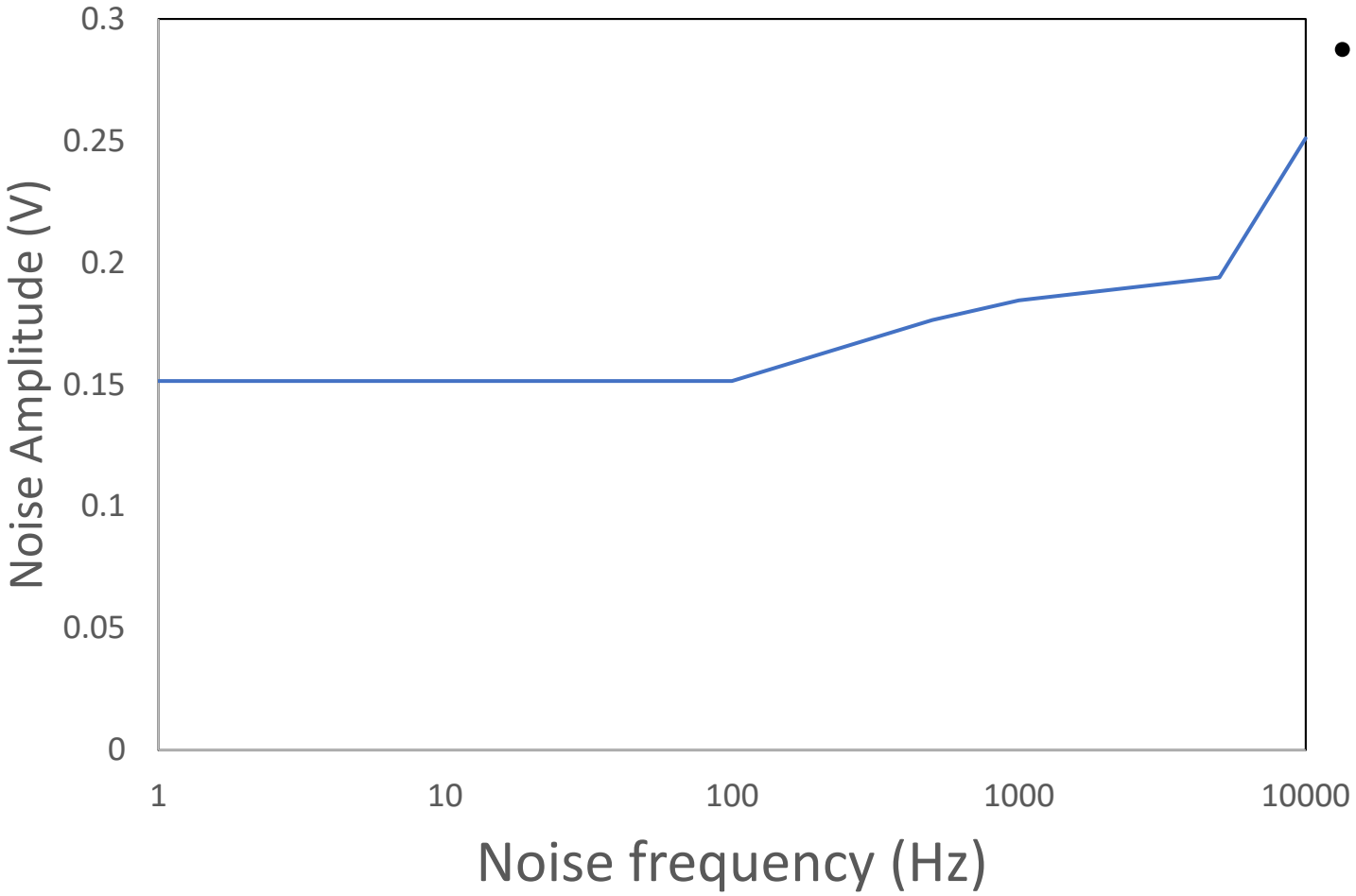
- Flowchart of EoS power-up state machine.



- It actually comes in 5-bit value.
- Some are decoded to integers.
- Idle state means it's ready to use

GBTx Manual v0.16, P.92

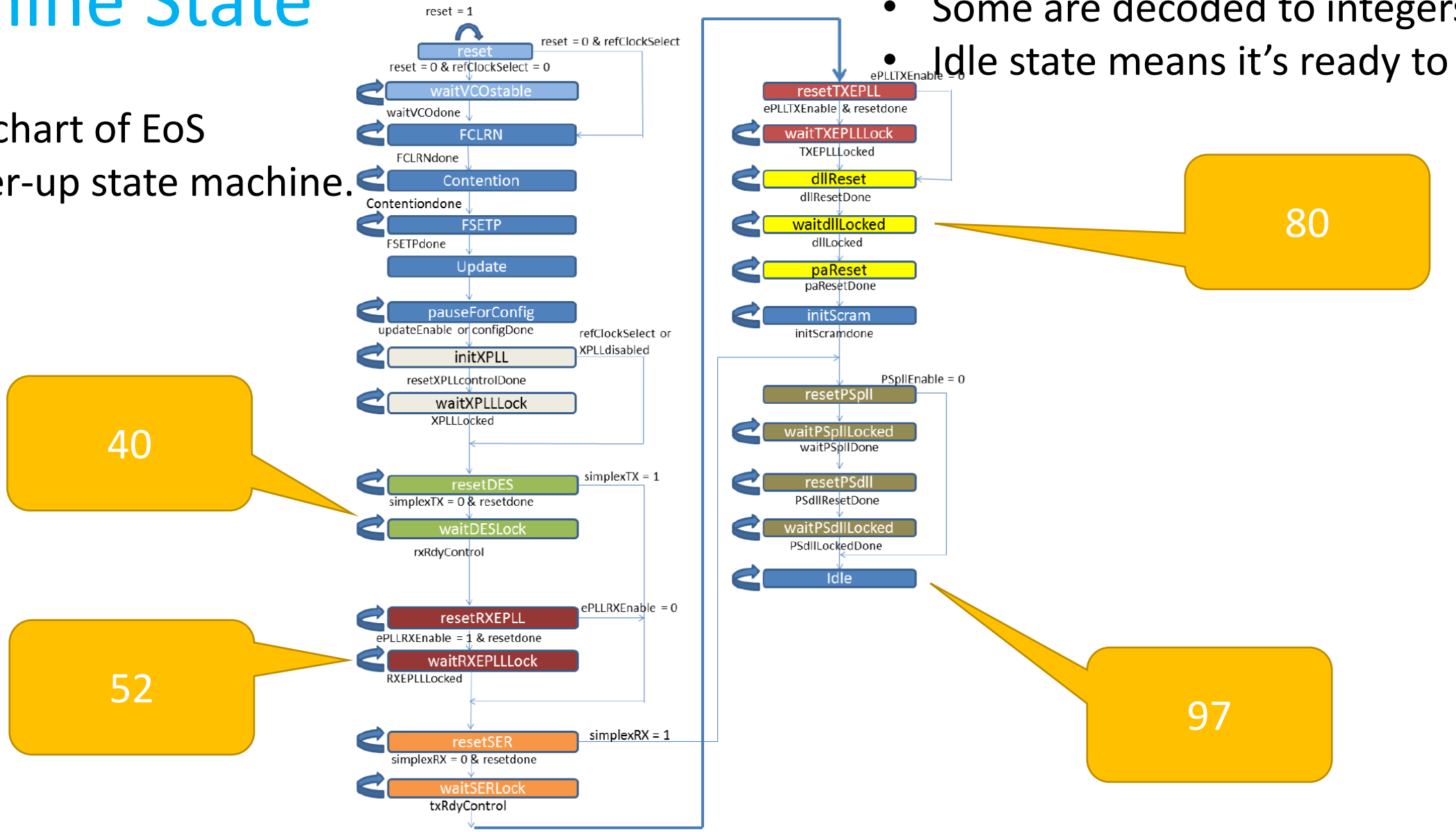
Noise amplitude to break idle state



- When noise frequency increases, needs higher noise amplitude to break the idle state.

Machine State

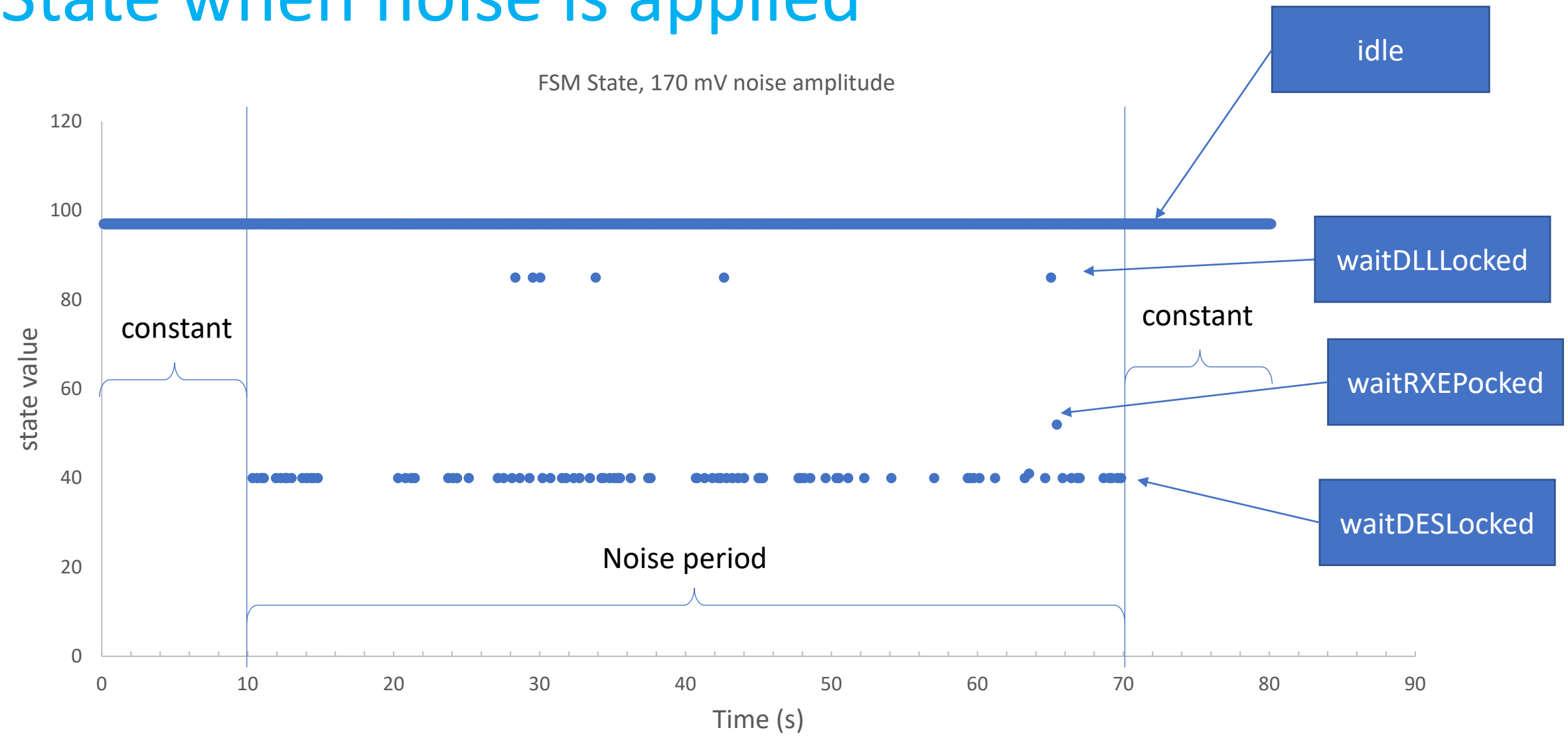
- Flowchart of EoS power-up state machine.



- It actually comes in 5-bit value.
- Some are decoded to integers.
- Idle state means it's ready to use

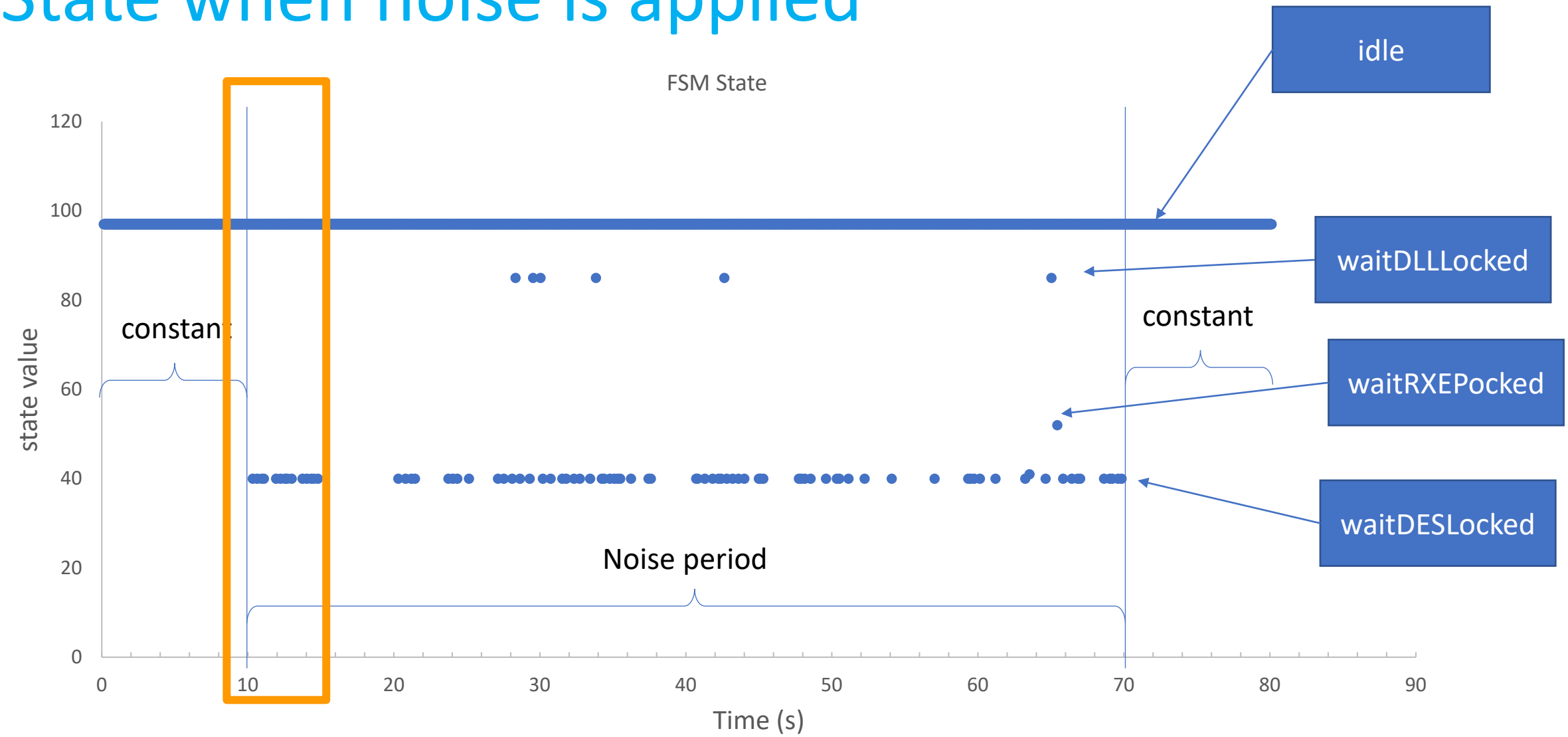
GBTx Manual v0.16, P.92

State when noise is applied



- State is read point by point with around 1/60 sec per point
- Numbers represent states of machine

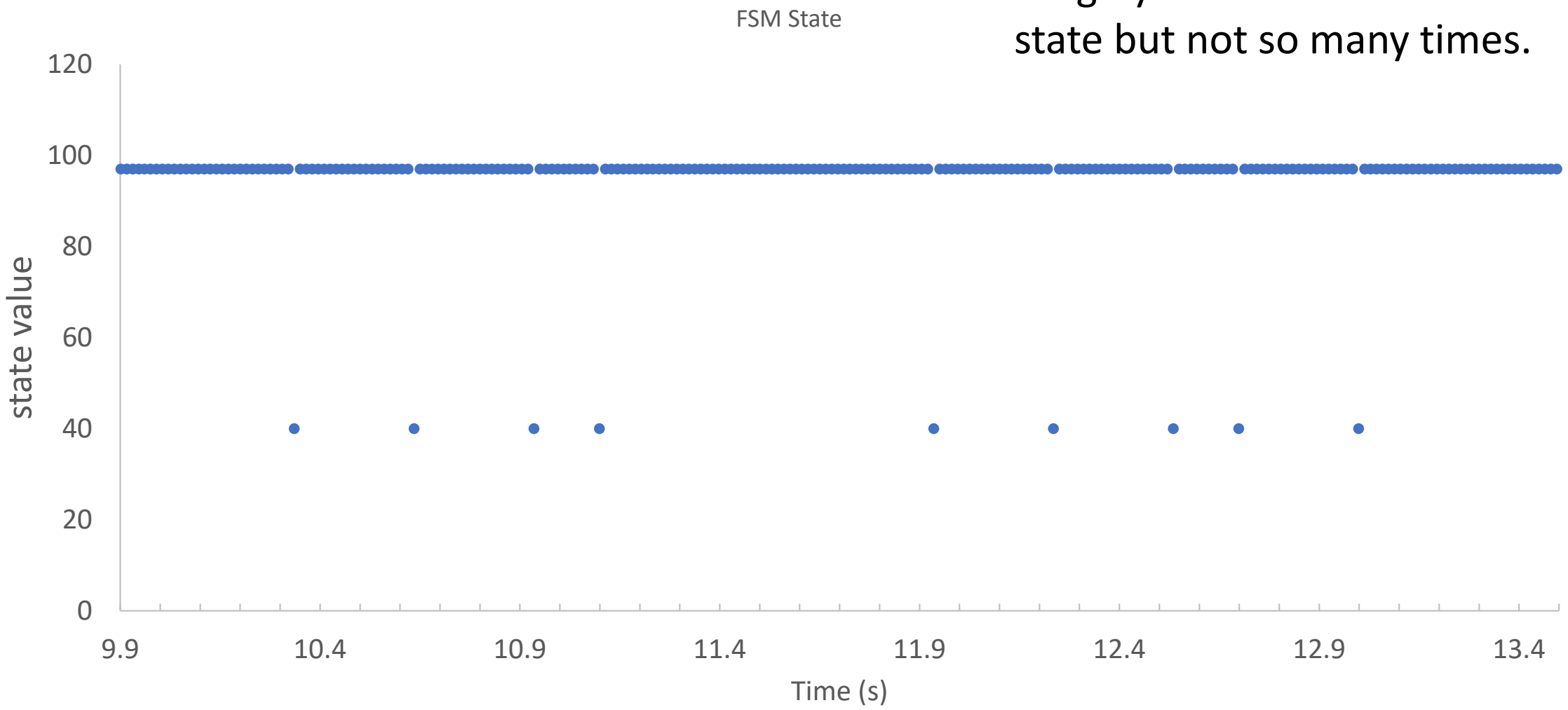
State when noise is applied



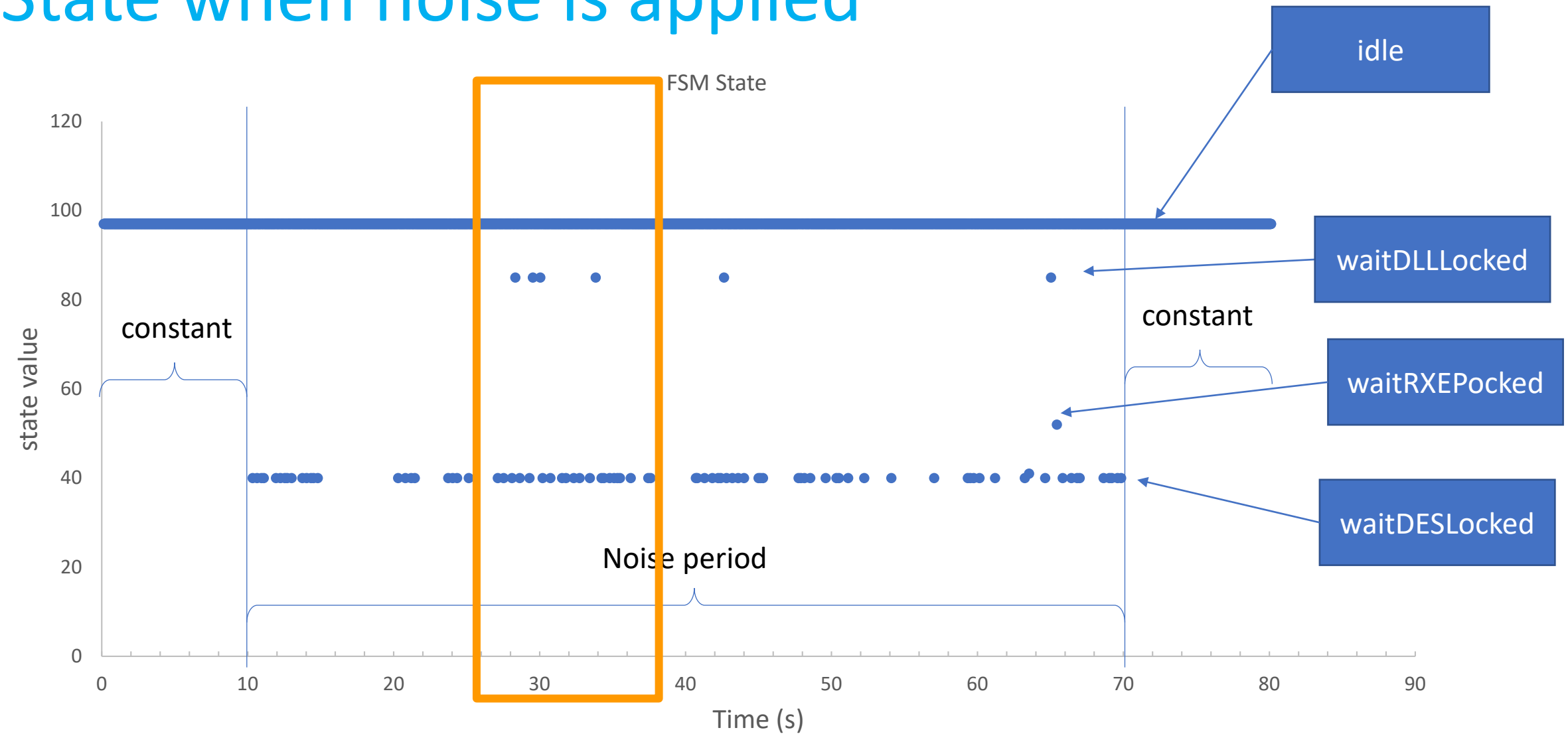
- State is read point by point with around 1/60 sec per point
- Numbers represent states of machine

State when noise is applied

- When noise begins, the state is roughly fall back to WaitDESLock state but not so many times.



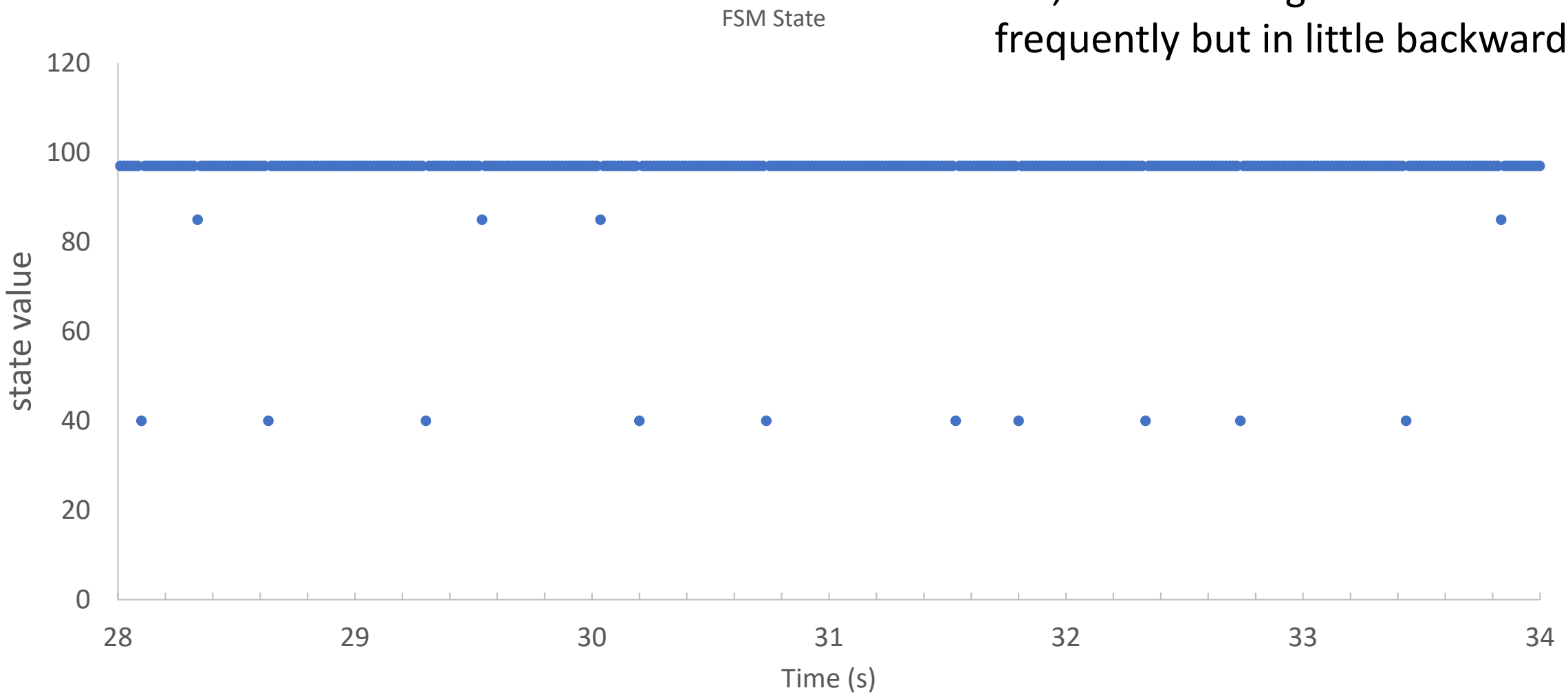
State when noise is applied



- State is read point by point with around 1/60 sec per point
- Numbers represent states of machine

State when noise is applied

- When experience noise for 30 sec, the state begins to fall a lot frequently but in little backward.



Conclusion

What we learn from the EoS Card Behaviour under sinusoidal noise;

- Clock and Input – low pass filter
- DAC-high pass filter or multiple passive component
- ADC- no significant effect
- State-the card maintains itself to idle state under

What to do next is overvoltage behavior and to test on lpGBT

Thank you